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Proceedings of the

Twenty-first Annual Meeting

CLEVELAND, OHIO.

Sept. 11 to 16, 1916

Volume XXV

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A. O. BACKERT

Secretary

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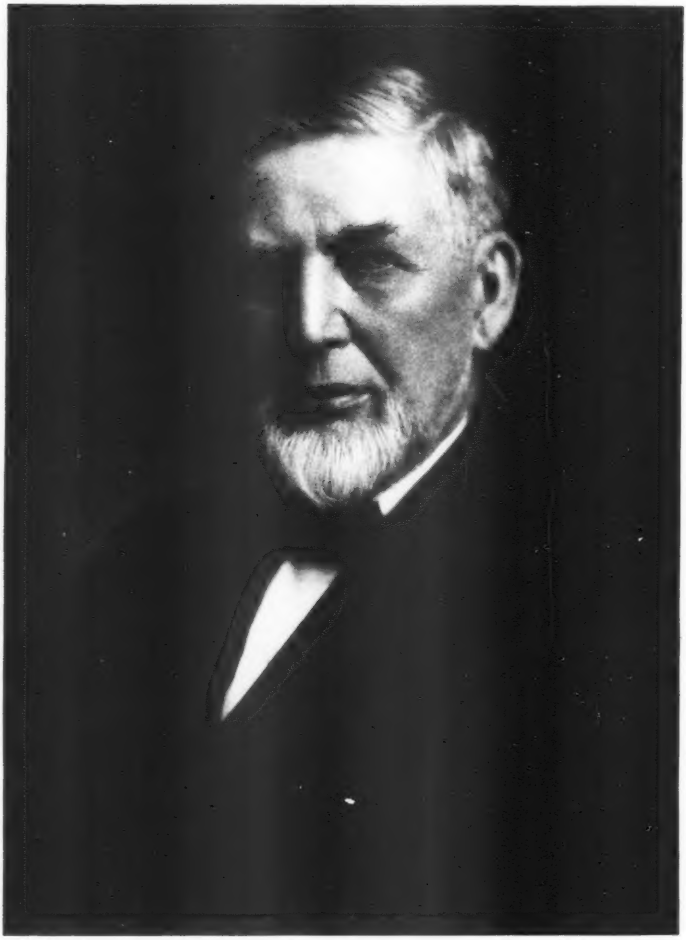

G. S. [illegible]

Joseph Sidney Seaman

President American Foundrymen's Association, 1899-1900

American Foundrymen's Association

Joseph Sidney Seaman

AFFECTIONATELY known as "Daddy" to the army of friends to whom he has endeared himself, Joseph Sidney Seaman, of Pittsburgh, the patriarch of the American foundry industry, has been a tower of strength to the American Foundrymen's Association since its organization in Philadelphia in 1896. Notwithstanding his 78 years, which rest lightly upon his broad shoulders, he continues his keen interest in the affairs of this organization and its officers constantly turn to him for guidance and advice which is tendered in that kindly spirit for which he is noted. His attendance at the annual convention of this society is one of the features of these meetings, and he anticipates these gatherings with almost juvenile joy. That his presence is looked forward to with equal pleasure by his host of friends is reflected by the warmth of his reception at each of these yearly meetings.

"To know 'Daddy' Seaman is to love him," is the unanimous verdict of those with whom he comes in contact and the honors and gifts that have been showered upon him by his force of employes, his fellow-members, civic and trade organizations, in a measure is indicative of the high esteem in which he is held by his fellow-man.

Oldest Living Past President

At the Pittsburgh convention of the American Foundrymen's Association, held in 1899, Mr. Seaman was elected president and presided in that capacity at the annual meeting in Chicago the following year when he was placed upon the honorary membership roll. Since that time he has served

on many committees and his work in behalf of this society has encompassed practically all of its activities.

As a token of love and regard, his fellow-members of the American Foundrymen's Association presented him with a hand-wrought silver pitcher and tray at the Chicago meeting in 1913, and the following address, delivered by former President Alfred E. Howell on this memorable occasion, expresses the sentiments of every member of this Association:

Mr. Seaman, and Gentlemen: The phenomenon of growth in nature is one that doubtless many, if not all of you, have pondered. The seed is planted; it germinates and by degrees we see the stem, the leaf, the bud, the perfect flower.

It is almost axiomatic in nature that the more highly developed and valuable the product, the longer the time in process. The soft wood grows rapidly, the hickory and the oak are of slow growth. Man of all living beings, the most helpless in the beginning, develops by slow degrees to the highest type of God's creatures.

Thus rapidly suggesting the proof of my corollary, I pass on to say that in 1896, in the incipiency of the American Foundrymen's Association, Mr. Seaman planted the flower that has blossomed these eighteen years, and ripened the fruit of perfect love.

It is difficult to tell just how and why certain things happen in this world. Sometimes we do things because we feel impelled by an invisible force. It is not at all a new idea, this of giving to you, Mr. Seaman, some token of our love. This year it seemed to permeate the atmosphere.

We wanted to give visible and tangible and enduring expression to those sentiments for you that fill our hearts.

In attempting to do so there is room for the widest divergence of opinion as to what could, if anything indeed can, adequately represent our feeling. You remember Harry Lauder's song. He is dancing with his girl and swings her around rather lustily. She shouts, "Jock, you will tear my frock, you will have me black and blue." He says, "I will buy you twenty frocks, that's how I am feeling the noo." Well, that's the way a good many felt, just like buying the whole shop. There's our friend M'Fadden, I think he would have purchased a loving cup as big as this rostrum. But no one has been allowed any special privileges in this matter. It is the many, each looked in for only a little, and the selection of this pitcher and waiter was controlled by the thought that we wanted to come to our friend in a close and intimate relation by service, as he has come to us and endeared himself, without ostentation or display.

Wrought by hand with thousands of loving licks of the hammer, these pieces symbolize the thousands of helpful thoughts that have guided us on our way to our present development. This token to you, Mr. Seaman, is not of love originating with us, but of love as reflected to you. We love you because you first loved us, and we hope you will keep these

near you and use them daily. And when you grasp this handle, let us fondly think you are grasping us by the hand, let us feel that we are ministering in this simple and homely fashion daily to our good and only true "Daddy".

Sketch of Mr. Seaman's Career

Joseph Sidney Seaman was born in Harmony, Butler county, Pennsylvania, April 14, 189. He was the third son of Elias and Charlotte (Goehring) Seaman. His father's ancestors settled in this country in the early part of the eighteenth century; his mother was of German abstraction. Elias Seaman, who was engaged in the saddlery and harness business, died in 1842, leaving a widow and five sons, William Henry, Elias Jefferson, Joseph Sidney, Edwin Marion and Francis Elias.

After attending the public schools in Harmony, Joseph Sidney entered Conoquenessing Academy in Butler county, where he remained for only a short time. Upon the completion of his education, he accepted work in a brick yard, but a few months later, when only 17 years old, he went to Pittsburgh, having accumulated enough money, in his opinion, to make his way in the world. "I had exactly $7.25 in my pockets when I landed in Pittsburgh," Mr. Seaman relates in telling about his early experiences. He wanted to become a carpenter, and for a year helped one of his brothers build cabins for river steamboats. Through Samuel Leonard, with whom he had become acquainted, young Seaman was given an opportunity to learn the roll turning trade and worked for four years in a shop in old Pipe Town, now Second avenue, Pittsburgh. Having become an efficient roll turner, he accepted a position with the Pittsburgh Foundry, owned by Messrs. Bowman and Garrison, which is now known as the A. Garrison Foundry Co. While employed by that concern he turned rolls for the first crucible steel made in Pittsburgh and also turned many of the cannon used in the Civil war.

Makes Cannon During Civil War

At the outbreak of the war, Mr. Seaman attempted to join the Union army, but was told by the recruiting officers, who had learned of his skill, that his duty was to remain at his post in the foundry. Mr. Seaman joined Knapp's battery,

but this organization was not called into service. A number of years after the war was ended, Mr. Seaman had an opportunity to buy many of the old iron cannon, which he purchased for scrap. When the cannon were delivered at Pittsburgh, he recognized one that he had turned out in the Pittsburgh Foundry. Mr. Seaman presented this cannon to the city and it is now on exhibition in Arsenal Park.

He left the Pittsburgh Foundry to take charge of the shop of Hussey, Wells & Co., where he worked for three years. The Black Diamond Steel Works, owned by Park Bros., engaged him to direct the work in the roll department and to build a number of new mills. In 1869, Mr. Seaman took advantage of an opportunity to enter the foundry business with a number of associates. A small plant was erected at Liberty and Twenty-fifth streets, and the company operated successively under the names of Bollman & Co.; Bollman, Boyd & Baggaley; Baggaley, Young & Co.; James B. Young & Co., and Seaman, Sleeth & Black. In 1885, the Seaman-Sleeth Co. was incorporated by Mr. Seaman and Robert Sleeth, who died a number of years ago. Mr. Sleeth was not actively connected with the company for many years before his demise.

Development of the Westinghouse Airbrake

During the period that Mr. Seaman operated the Liberty street plant, the late George Westinghouse was busily engaged developing the airbrake and a number of other mechanical devices. He conferred with Mr. Seaman and Mr. Baggaley many times, asking them for suggestions and advice. The first airbrake developed by Mr. Westinghouse was made in the Liberty street foundry. Shortly after the airbrake had been introduced, the Westinghouse Airbrake Co. purchased the properties of the Seaman-Sleeth Co., which subsequently erected a plant, 80 x 80 feet, on Forty-second street, near the Allegheny Valley railroad, on the site of an old glass house. A partition divided the building into two sections of equal area; the foundry was located in one section and the remainder of the building was used for finishing work. The company has since extended the plant to a great extent and has increased the capacity from about 10 tons to 50 tons a day.

Mr. Seaman is a past president and a former treasurer of the Pittsburgh Foundrymen's Association, and is a member of the Duquesne Club, the Country Club and the Pittsburgh Athletic Association of Pittsburgh, the Engineers' Society of Western Pennsylvania, the American Iron and Steel Institute, the Pittsburgh Chamber of Commerce, and the United States Chamber of Commerce. He is president of the Pennsylvania National Bank and the Pennsylvania Savings Bank and is chairman of the board of the Passavant hospital, Pittsburgh.

Written Testimonial from Employes

On his seventy-fifth birth anniversary, April 14, 1914, employes of the Seaman-Sleeth Co. presented him a written testimonial, expressing their high regard for their employer. Two hundred and twenty-five men, several of whom had been identified with the company for two scores of years, attached their signatures to a document which has since hung in Mr. Seaman's office.

Mr. Seaman was married in 1864 to Miss Alice Slater, of Pittsburgh, who died in 1905. She was survived by her husband, one son, Joseph Sidney Seaman Jr., and one daughter, Mrs. James H. Hammond, of Pittsburgh.

Summary of the Proceedings of the Twenty-First Annual Meeting

Cleveland, O., Sept. 11 to 16, 1916

A record-breaking attendance featured the twenty-first annual meeting of the American Foundrymen's Association, held at Cleveland from Monday, Sept. 11, to Friday, Sept. 15, 1916, inclusive. The one-session-per-day plan was inaugurated and met with the hearty approval of all the members. Seven technical sessions were held, the meetings on Monday and Tuesday having been conducted jointly with the American Institute of Metals; general topics were considered on Wednesday, while simultaneous sessions were held Thursday and Friday for the discussion of steel and malleable iron, and steel and gray iron respectively. The attendance set a new high mark with a total registration of 889 members and 194 ladies. This compares with an enrollment of 515 members and 209 ladies at Atlantic City last year.

Joint Opening Session

Monday, Sept. 11, 2:30 *p. m., Hotel Statler*

R. A. Bull, president of the American Foundrymen's Association in the chair.

In the absence of Hon. Harry L. Davis, mayor of the city of Cleveland, the address of welcome was delivered by Lamar T. Beman, director of public welfare. Response was made by Alfred E. Howell, Phillips & Buttorff Mfg. Co., Nashville, Tenn.

R. A. Bull, president of the American Foundrymen's Association, then presented his annual address which included a summary of the activities of the executive board, the committee on incorporation and the committee on exhibition affairs.

This was followed by the annual address of Jesse L. Jones, president of the American Institute of Metals.

The report of the secretary-treasurer of the American Foundrymen's Association, A. O. Backert, then was submitted as well as the report of the public accountants, Ernst & Ernst, Cleveland, O.

Chairman R. A. Bull then announced the appointment of the following convention committees:

Committee on Resolutions.—S. B. Chadsey, chairman, Massey-Harris Co., Ltd., Toronto, Ont.; V. E. Minich, Sand Mixing Machine Co., New York City, and W. B. Robinson, *The Iron Age,* Pittsburgh.

Committee for the Nomination of Directors of the American Foundrymen's Association, Incorporated.—Alfred E. Howell, chairman, Phillips & Buttorff Mfg. Co., Nashville, Tenn.; J. S. Seaman, Seaman-Sleeth Co., Pittsburgh; W. H. McFadden, Ponca City, Okla.; S. D. Sleeth, Westinghouse Air Brake Co., Pittsburgh and C. H. Gale, Pressed Steel Car Co., McKees Rocks, Pa.

Second Joint Session

Tuesday, Sept. 12, 10:00 *a. m., Hotel Statler*

R. A. Bull, president of the American Foundrymen's Association, in the chair.

The following papers and reports were presented:

Symposium on "The Results of Closer Co-operation Between the Engineer and the Foundry", as relating to:

"Gray Iron," by D. W. Sowers, Sowers Mfg. Co., Buffalo.

"Steel," by John Howe Hall, Taylor-Wharton Iron & Steel Co., High Bridge, N. J.

"Malleable Iron," by G. F. Meehan, Ross-Meehan Foundries, Chattanooga, Tenn.

"Non Ferrous Metals", by T. E. Chase, Modjeski & Angier, Chicago.

Symposium on "The Influence of Gating on Castings", covering:

"Gray Iron," by B. D. Fuller, Westinghouse Electric & Mfg. Co., Cleveland.

"Steel," by William Gilmore, Hubbard Steel Foundry Co., East Chicago, Ind.

"Malleable Iron," by A. M. Fulton, Fort Pitt Malleable Iron Co., Pittsburgh.

"Non-Ferrous Metals," by R. R. Clarke, Pennsylvania Lines West, N. S. Pittsburgh.

"Waste Foundry Sand", by H. B. Swan, Cadillac Motor Car Co., Detroit, and H. M. Lane, consulting engineer, Detroit.

"Report of Work on Molding Sand", by S. W. Stratton, Director, United States Bureau of Standards, Washington, D. C.

"The Significance of the Fire Waste", by Franklin H. Wentworth, secretary, National Fire Protection Association, Boston.

"The Training of Young Men for the American Foundry Industry", by John A. Rathbone, Pratt Institute, Brooklyn, N. Y.

"Analyzing Foundry Operations as a Basis for Improvement in Shop Conditions", by R. E. Kennedy, University of Illinois, Urbana, Ill.

"Foundry Work at the University of Nebraska", by John Grennan, University of Nebraska, Lincoln, Neb.

A resolution offered by Richard Moldenke was adopted, which provides for the appointment of a committee to co-operate with the United States Bureau of Mines, in an investigation of the reclamation of waste foundry sand. The chairman, R. A. Bull, announced that the members of this committee would be appointed by his successor.

Franklin H. Wentworth, who delivered an address on "The Significance of the Fire Waste", suggested that the American Foundrymen's Association and the American Institute of Metals appoint a committee to investigate the subject of fire protection in foundries and it was the sense of the meeting that this question be referred to the Committee on Safety and Sanitation,

with the suggestion that it possibly might be advisable to change the name of the committee to "Safety, Sanitation and Fire Protection".

THIRD SESSION

Wednesday, Sept. 13, 10:00 *a. m., Hotel Statler*

R. A. Bull, president of the American Foundrymen's Association, in the chair.

The following papers and reports were presented:

Report of the A. F. A. Committee on Foundry Costs, by B. D. Fuller, chairman, Westinghouse Electric & Mfg. Co., Cleveland.

"Foundry Costs", by C. H. Scovell, Clinton H. Scovell & Co., Boston.

"Profit-Sharing as a Factor in Preparedness", by C. E. Knoeppel, C. E. Knoeppel & Co., New York.

Report of A. F. A. Committee on Foundry Scrap, by G. E. Jones, chairman, Whiting Foundry Equipment Co., Harvey, Ill.

Report of A. F. A. representatives on the Conference Board on Training of Apprentices, by B. D. Fuller, chairman, Westinghouse Electric & Mfg. Co., Cleveland.

Report of A. F. A. Advisory Committee to the United States Bureau of Standards, Washington, D. C.

Report of A. F. A. Committee on Safety and Sanitation, by Victor T. Noonan, chairman, Industrial Commission of Ohio, Columbus, O.

"How Some Cleaning Room Problems Have Been Solved", by H. Cole Estep, associate editor, *The Foundry*, Cleveland.

"The Introduction of the Molding Machine in Foundries", by A. O. Backert, Penton Publishing Co., Cleveland.

A resolution was adopted authorizing the A. F. A. Committee on Uniform Foundry Costs, to investigate some of the various systems that have been adopted by different associations, and to report its findings within three months from the time of the convention, to the board of directors of the American Foundrymen's Association, Incorporated, the latter being empowered to carry out any plan which seems most expedient to make more effective uniform cost work among foundrymen.

This resolution was not intended to involve the American Foundrymen's Association, Incorporated, financially, and if some plan can be devised whereby the adoption of the uniform cost system can be made more effective, it is the intention to have the cost defrayed by the various foundrymen sharing in the benefits accruing from such associated effort.

The report of the A. F. A. Committee on Foundry Scrap, submitted by G. E. Jones, chairman, Whiting Foundry Equipment Co., Harvey, Ill., containing a complete list of specifications, was adopted unanimously.

A resolution authorizing the board of directors of the American Foundrymen's Association, Incorporated, to adopt the government standard for sieves prepared by the United States Bureau of Standards, received unanimous approval and the board of directors was empowered to adopt this standard some time during the year.

A motion was presented and adopted unanimously, which provides that the representatives of the American Foundrymen's Association on the Conference Board on Training of Apprentices, be empowered to draft apprentice regulations and submit them to the board of directors of the Association for whatever action it seems necessary to take.

A resolution was adopted providing for the appointment of a committee to compile information with reference to suitable apprenticeship indentures, and that the information received from this investigation be sent to each member of the Association. The appointment of this committee, however, first must be sanctioned by the board of directors of the American Foundrymen's Association, Incorporated.

The report of the A. F. A. Committee on Safety and Sanitation, which provided for the adoption of a safety code for foundries, was referred to a committee consisting of J. P. Pero, Missouri Malleable Iron Co., East St. Louis, Ill., president of the American Foundrymen's Association, Incorporated, and H. D. Miles, Buffalo Foundry & Machine Co., Buffalo, with instructions to co-operate with a committee of the National Founders' Association to draft a safety code which will be representative of both organizations. This safety code is to be submitted at the next annual meeting of the American Foun-

drymen's Association, and if it is impossible to draft a suitable code for both associations, the report of the committee conferences is to be submitted.

After a careful discussion of the safety code reported by the committee, the following resolution was submitted and was adopted unanimously:

> *Whereas,* The responsibility of safeguarding and preventing of accidents at present is placed entirely upon employers, and
>
> *Whereas,* Accident statistics show conclusively that a very large percentage of industrial accidents are caused by employes deliberately neglecting to use the safety devices provided and wilfully disobeying the shop safety regulations,
>
> *Be It Therefore Resolved,* That the American Foundrymen's Association, now in session, recommends to the Governors of each state as well as all State Labor Departments that part responsibility of accident prevention be placed upon the employes by the passing and strict enforcement of laws making it a misdemeanor to not use the safety devices provided or to wilfully disobey shop safety regulations.
>
> *Be It Further Resolved,* That much good will also be accomplished in the prevention of accidents if all State Factory Inspectors will report not only existing dangerous conditions, but also cases where employes have been observed disobeying safety precautions. These infractions should be called to the attention of the workmen by the Inspector himself.

Alfred E. Howell directed attention to the sudden illness of Major Jos. T. Speer, Pittsburgh Valve Foundry & Construction Co., Pittsburgh, which made it impossible for him to attend this annual meeting. He pointed out that on Friday, Sept. 15, Major Speer would enter upon another milestone in his career and he made a motion that a committee of three be appointed to send a message of greeting and appreciation to Major Speer. The committee appointed by the chairman consisted of W. H. McFadden, J. P. Pero and Alfred E. Howell.

The following communication was sent to Major Speer and a token of appreciation and esteem was delivered to him in person by W. H. McFadden:

Cleveland, Ohio, Sept. 14, 1916.

To Major Joseph T. Speer,
Pittsburgh, Pa.

The American Foundrymen's Association, in convention assembled at Cleveland, is aware of your absence, with the greatest regret. The convention is unwilling to be deprived of the inspiration of your presence, and the individual members of your hearty handshake and words of good cheer, without communicating to you their deep disappointment. As their chief executive for two terms, as their constant resource for wisdom and advice, as their ever present help in time of doubt and uncertainty, as the man without whose presence and counsel they are unaccustomed to act, they are thinking of you now and desire to convey to you their hearty greetings and their earnest hope that the separation shall be but brief.

The convention deputizes this sentiment to be conveyed to you by a very special messenger and to be tokened by flowers whose beauty and fragrance are emblems of our love and devotion.

This communication was signed by R. A. Bull, president, and A. O. Backert, secretary, of the American Foundrymen's Association, by the committee consisting of W. H. McFadden, J. P. Pero and Alfred E. Howell, and also by the following members: J. S. Seaman, B. D. Fuller, C. E. Hoyt, S. B. Chadsey, V. E. Minich, S. T. Johnston, H. B. Swan, H. A. Carpenter, W. A. Janssen, S. Griswold Flagg III, C. B. Connolly, W. B. Robinson, J. S. McCormick, E. D. Frohman, C. H. Gale, S. D. Sleeth and Wm. Yagle.

The Chairman, R. A. Bull, then offered the following resolution, which was adopted unanimously:

Whereas, The Executive Board of the American Foundrymen's Association, an incorporated society, has formed and organized a corporation not for profit, under the laws of the state of Illinois, to the end of amalgamating and merging this unincorporated association into said American Foundrymen's Association, Incorporated,

Now, therefore, be it resolved by the members of the American Foundrymen's Association, in annual meeting assembled, as follows:

First.—That the action of the members of the Executive Board of this unincorporated association in forming and incorporating the American Foundrymen's Association under the laws of the state of Illinois, be, and the same is hereby

fully ratified, confirmed and approved; and this unincorporated association is hereby declared to be fully, finally and completely amalgamated with, and merged in said American Foundrymen's Association, incorporated under the laws of the state of Illinois, aforesaid.

Second.—That all of the property, assets, moneys and supplies, of, or belonging to, this association are hereby transferred to, and declared to be the property, assets, moneys and supplies of the said American Foundrymen's Association, Incorporated, upon condition, however, that the said incorporated association shall and does, without reservation or exception, assume, adopt and agree to pay and discharge and perform all contracts, debts and obligations of this unincorporated association, keeping this association forever harmless therefrom.

Third.—That upon the acceptance by said American Foundrymen's Association, Incorporated, of the terms and conditions specified in these resolutions, this unincorporated association shall be considered fully and finally dissolved, except that its members and officers may do and perform any act necessary to effectuate in legal form the amalgamation and merger provided for in these resolutions.

After the adoption of the foregoing resolution, the chairman, R. A. Bull, called to order a meeting of the American Foundrymen's Association, Incorporated. The following resolution then was presented and unanimously adopted:

Whereas, The American Foundrymen's Association, an unincorporated society, has this day, in annual meeting assembled, passed and adopted certain resolutions in words as follows:

Whereas, The Executive Board of the American Foundrymen's Association, an unincorporated society, has formed and organized a corporation not for profit, under the laws of the state of Illinois, to the end of amalgamating and merging this unincorporated association into said American Foundrymen's Association, Incorporated.

Now, therefore, be it resolved by the members of the American Foundrymen's Association, in annual meeting assembled, as follows:

First.—That the action of the members of the Executive Board of this unincorporated association in forming and incorporating the American Foundrymen's Association under the laws of the state of Illinois, be, and the same is hereby fully ratified, confirmed and approved; and this unicorporated association is hereby declared to be fully, finally and completely amalgamated with, and merged in, said American Foundrymen's Association, incorporated under the laws of the state of Illinois, aforesaid.

Second.—That all of the property, assets, moneys and supplies of, or belonging to, this association are hereby transferred to and declared to be the property, assets, moneys and supplies of, the said American Foundrymen's

Association, Incorporated: Upon condition, however, that the said incorporated association shall and does, without reservation or exception, assume, adopt and agree to pay and discharge and perform all contracts, debts and obligations of this unincorporated association, keeping this association forever harmless therefrom.

Third.—That upon the acceptance by said American Foundrymen's Association, Incorporated, of the terms and conditions specified in these resolutions, this unincorporated association shall be considered fully and finally dissolved, except that its members and officers may do and perform any act necessary to effectuate in legal form the amalgamation and merger provided for in these resolutions.

Now, therefore, be it resolved, by the American Foundrymen's Association, Incorporated, in annual session duly assembled, that the terms and conditions of the foregoing resolutions adopted by said unincorporated association be, and the same are hereby accepted, approved, ratified and confirmed; and said American Foundrymen's Association, unincorporated, is hereby declared to be fully, finally and completely amalgamated with, and merged in, this association, a corporation organized under the laws of the state of Illinois.

Be it further resolved that all persons who are members in good standing of said unincorporated association, are hereby declared to be entitled to membership in this association upon complying with the by-laws of this association relating to the subject of membership.

Be it further resolved, that the Board of Directors and other officers of this association are hereby fully authorized and empowered to perform all acts necessary to complete the amalgamation and merger aforesaid according to the terms and conditions set forth in these resolutions.

The report of the nominating committee empowered to nominate 16 directors for the American Foundrymen's Association, Incorporated, then was submitted and it was moved unanimously that the report be received and accepted and the secretary was instructed to cast the ballot for the election of the following to serve one year as members of the board of directors of the American Foundrymen's Association, Incorporated:

R. A. Bull, Commonwealth Steel Co., Granite City, Ill.

A. O. Backert, Penton Publishing Co., Cleveland.

Henry A. Carpenter, General Fire Extinguisher Co., Providence, R. I.

S. B. Chadsey, Massey-Harris Co., Ltd., Toronto, Ont.

H. S. Covey, Cleveland Pneumatic Tool Co., Cleveland.

Alex T. Drysdale, U. S. Cast Iron Pipe & Foundry Co., Burlington, N. J.

Stanley G. Flagg III, Stanley G. Flagg & Co., Philadelphia.

Benj. D. Fuller, Westinghouse Electric & Mfg. Co., Cleveland.

C. E. Hoyt, Lewis Institute Building, Chicago.

Alfred E. Howell, Phillips & Buttorff Mfg. Co., Nashville, Tenn.

W. A. Janssen, Bettendorf Co., Davenport, Ia.

S. T. Johnston, S. Obermayer Co., Chicago.

V. E. Minich, Sand Mixing Machine Co., New York.

J. P. Pero, Missouri Malleable Iron Co., East St. Louis, Ill.

Jos. T. Speer, Pittsburgh Valve Foundry & Construction Co., Pittsburgh.

H. B. Swan, Cadillac Motor Car Co., Detroit.

The nominating committee was constituted as follows: Alfred E. Howell, chairman; J. S. Seaman, W. H. McFadden, S. D. Sleeth and C. H. Gale. In submitting the report of this committee, Alfred E. Howell, chairman, stated that in its deliberations the committee was not unmindful of the fact that in the transition of the Association from an unincorporated to an incorporated body, a large number of meetings were required involving a great deal of work on the part of the executive board of the American Foundrymen's Association and that with few exceptions these members were almost constantly in attendance at the necessary meetings, and therefore, the committee with two exceptions, recommended the nomination of the 16 members who served last year. These two gentlemen not renominated were unable to attend the meetings and to serve in their stead, Stanley G. Flagg III and S. B. Chadsey were placed in nomination.

The chairman, R. A. Bull, announced that the 16 directors named in the articles of incorporation to serve one year from the granting of the charter, all had tendered their resignations effective Sept. 13, 1916, in order that the members of the corporation could select those who they preferred to have serve them as directors.

Steel Session

Thursday, Sept. 14, 10:00 *a. m., Hotel Statler*

W. A. Janssen in the chair.

The following papers and reports were presented:

Symposium on "Electric Furnace Practice"—

"The Ideal Electric Furnace for the Steel Foundry", by F. J. Ryan, E. B. McKee and W. D. Walker, Snyder Electric Furnace Co., Chicago.

"The Electric Furnace in the Foundry" by E. B. Clark, Buchanan Electric Steel Co., Buchanan, Mich.

"Gronwall-Dixon Electric Melting and Refining Furnace", by John A. Crowley, John A. Crowley Co., New York.

"Electric Furnace Practice in the Manufacture of Steel Castings", by T. S. Quinn, Lebanon Steel Foundry, Lebanon, Pa.

"The Manufacture of Manganese Steel Castings", by W. S. McKee, American Manganese Steel Co., Chicago.

"The Presence of Alumina in Steel", by G. F. Comstock, Titanium Alloy Mfg. Co., Niagara Falls, N. Y.

Malleable Session

Thursday, Sept. 14, 10:00 *a. m., Hotel Statler*

Vice President J. P. Pero in the chair.

The following papers and reports were read:

"The 25-Ton Air Furnace", by F. C. Rutz, Rockford Malleable Iron Works, Rockford, Ill.

"What is the Normal Fracture of Good Malleable Iron?", by Enrique Touceda, Albany, N. Y.

"The Commercial Side of the Malleable Iron Industry", by W. G. Kranz, National Malleable Castings Co., Cleveland.

"The Application of Malleable Iron Castings in Car Construction", by Frank J. Lanahan, Fort Pitt Malleable Iron Co., Pittsburgh.

Report of the A. F. A. Committee on Standard Specifications for Malleable Iron Castings, by Enrique Touceda, chairman, Albany, N. Y.

"Suggested Standards for Pattern Parts", by W. W. Carlson, Kansas State Agricultural College, Manhattan, Kan.

The progress report on Standard Specifications for Malleable Iron Castings, by Enrique Touceda, chairman, Albany, N. Y., was adopted unanimously.

Steel Session

Friday, Sept. 15, 10:00 *a. m., Hotel Statler*

W. A. Janssen in the chair.

The following papers and reports were presented:

"The Use of Titanium in the Manufacture of Steel Castings", by W. A. Janssen, Bettendorf Co., Davenport, Ia.

"Acid Versus Basic Steel for Making Castings", by E. F. Cone, *The Iron Age,* New York.

"Alloy Steel Castings", by David Evans, Chicago Steel Foundry Co., Chicago.

"Theory and Practice in Gating and Heading Steel Castings", by Ralph D. West, West Steel Casting Co., Cleveland.

Report of A. F. A. Committee on Specifications for Steel Castings, by John Howe Hall, chairman, Taylor-Wharton Iron & Steel Co., High Bridge, N. J.

The report of the A. F. A. Committee on Specifications for Steel Castings, by John Howe Hall, chairman, Taylor-Wharton Iron & Steel Co., High Bridge, N. J., was adopted unanimously.

Gray Iron Session

Friday, Sept. 15, 10:00 *a. m., Hotel Statler*

Benjamin D. Fuller in the chair.

The following papers and reports were read:

"The Effects of Different Mixtures on the Strength of Chilled Car Wheels", by G. S. Evans, Lenoir Car Works, Lenoir City, Tenn.

"Semi-Steel Classified", by David McLain, McLain's System, Milwaukee.

Report of A. F. A. Committee on Standard Methods for Analyzing Coke, by H. E. Diller, chairman, General Electric Co., Erie, Pa.

"Use of By-Product Coke in Foundries", by George A. T. Long, Pickands, Brown & Co., Chicago.

"The Use of Borings in Cupola Operations", by James A. Murphy, Hooven, Owens & Rentschler Co., Hamilton, O.

"The Use of Cheaper Materials", by C. C. Kawin, Charles C. Kawin Co., Chicago.

"One-Third of a Century in a Gray Iron Foundry", by Alfred E. Howell, Phillips & Buttorff Mfg. Co., Nashville, Tenn.

"Thermal Reactions in Gray Iron", by Thomas Turner, The University, Birmingham, Eng.

Report of A. F. A. Committee on General Specifications for Gray Iron Castings, by W. P. Putnam, chairman, Detroit Testing Laboratory, Detroit.

The report of the A. F. A. Committee on Standard Methods of Coke Analysis, presented by H. E. Diller, chairman, was adopted as a tentative specification to be tried out during the ensuing year.

A rising vote of thanks was tendered to Prof. Thomas Turner, The University, Birmingham, Eng., for his excellent paper entitled "Thermal Reactions in Gray Iron", and the secretary was instructed to communicate to Prof. Turner the action taken.

The following progress report on general specifications for gray iron castings, submitted by W. P. Putnam, chairman, Detroit Testing Laboratory, Detroit, was adopted:

Detroit, Mich., Sept. 6, 1916.

Mr. A. O. Backert, Sec. and Treas.,
American Foundrymen's Association,
Cleveland.

Dear Sir:—

During the year, 1915-16, preliminary work has been done in the line of making appointments of sub-committee chairmen, as follows:

Agricultural Castings, John H. Ploehn, Davenport, Ia.
Chemical Castings, H. D. Miles, Buffalo.
Car Wheels, J. M. Keller, St. Louis.
Hydraulic and Steam Castings, R. S. MacPherron, Milwaukee.
Pipe Castings, Alex T. Drysdale, Burlington, N. J.
Automobile Castings, J. J. Wilson, Detroit.

Owing to the unprecedented condition in all foundries during the past year it has been almost impossible to get

committeemen to devote any time to the work placed in the hands of this committee. By dividing the work as outlined it is our hope that it will go forward without further delay and a start made in this important field.

Respectfully submitted,

W. P. PUTNAM,
Chairman

The report of the sub-committee on specifications for cast iron pipe, submitted by Alex T. Drysdale, chairman, U. S. Cast Iron Pipe & Foundry Co., Burlington, N. J., was referred to the committee on general specifications for gray iron castings.

The report of the sub-committee on cast iron pipe follows:

Your sub-committee having in charge the specifications for cast iron pipe beg to submit the following report:

When in 1902 the New England Water Works Association adopted standard specifications for cast iron pipe, the first attempt in this country at standardizing cast iron pipe was made.

May 12, 1908, the American Water Works Association adopted specifications for cast iron pipe. These specifications, while containing fewer pipe classes, cover a wider range of service than the New England specifications. That they have met with favor is proven by the fact that they have been adopted by many of the most prominent cities and towns of this country, by the Canadian Society of Civil Engineers, by some of the British manufacturers and by practically all of the pipe manufacturers in the country.

In 1905 the American Gas Light Association adopted the first standard for cast iron gas pipe. The specifications were later revised and in October, 1913, the American Gas Institute adopted the specifications which are now recognized by practically all the gas companies of this country and also by all the manufacturers of cast iron pipe.

Inasmuch as these two specifications for cast iron pipe have been adopted by so many users of cast iron pipe and by so many of the engineering societies, and as the manufacturers have prepared patterns, flasks, etc., for their manufacture at enormous expense, it does not seem advisable, at this time, to change either of them and the sub-committee recommends that they both be adopted as standards just as they are.

ALEX T. DRYSDALE, Chairman.
D. P. HOPKINS,
J. F. KENT.
WALTER WOOD.

The following communication was received by President R. A. Bull from the sub-committee on reorganization and

enlargement of membership of committee A-3 of the American Society for Testing Materials:

Cleveland, O., Sept. 11, 1916.

Mr. R. A. Bull, President,
The American Foundrymen's Association,
Cleveland, Ohio.

Dear Sir:

In view of the fact that the American Society for Testing Materials is today recognized along almost all lines as a clearing house for specifications on materials of construction, protective coatings, etc.; that their position in this particular is yearly becoming more strong, both here and abroad and that it is highly desirable to have in the transactions of one society only, all specifications that are considered authoritative, in order to simplify matters and avoid complications that arise when specifications are issued from various sources. It is our belief that the A. S. T. M. are interested in only adopting those specifications that not only protect the purchaser, but do not run counter to works practice or embarrass the manufacturer by provisions that he will find commercially impracticable.

In consideration of the foregoing it is the thought of this committee that it would further your interest, as well as that of the A. S. T. M. and the engineering world if we secured your co-operation and advice. With this in view the following motion was adopted by this committee at a meeting held this afternoon:

"That the American Foundrymen's Association be invited to accept membership on the A. S. T. M., Com. A-3; to designate a representative on each of the sub-committees of Com. A-3; to signify which of the present A. S. T. M. specifications, under jurisdiction of Com. A-3, they consider are in need of revision and also of any materials not now covered by the A. S. T. M., for which you feel a specification should be formulated."

In closing, this committee desires to point out that a number of the members of your Association now hold individual memberships on Com. A-3; this being especially true of this sub-committee, as all members of it, except the chairman, are members of your Association.

S. V. Hunnings,
Enrique Touceda,
H. E. Diller,
R. S. MacPherron.

Sub-Committee, Reorganization and Enlargement of Membership, Committee A-3.

The foregoing was presented for consideration at a meeting of the board of directors of the American Foundrymen's Association, Incorporated, held at the Hollenden Hotel, Cleveland, Monday evening, Sept. 11, where action was taken heartily

concurring in the suggestions made, providing for the American Foundrymen's Association having representation on Committee A-3 of the American Society for Testing Materials and its various sub-committees and that all specifications for gray iron castings prepared by the American Society for Testing Materials be presented to the American Foundrymen's Association for discussion and ratification.

The following resolution then was submitted by the committee on general specifications for gray iron castings of the American Foundrymen's Association:

> Be it resolved that it is the unanimous opinion of this Committee on General Specifications for Gray Iron Castings that this committee be continued under its present identity, to meet, discuss and form its tentative specifications; the said specifications to be presented to the American Society for Testing Materials by the American Foundrymen's Association representatives on the A-3 committee of the A. S. T. M., as the official recommendations of the A. F. A.
>
> Be it further resolved, that after said specifications have been agreed upon by the A. S. T. M. A-3 committee, these specifications be submitted to the A. F. A. for discussion and ratification.
>
> W. P. Putnam, Chairman,
> D. W. Sowers,
> Richard Moldenke,
> John H. Ploehn,
> R. S. MacPherron.
> G. S. Mitchell,
> H. B. Swan.

A motion, adopted unanimously, provided that the report of the Committee on General Specifications for Gray Iron Castings be received and accepted and that the committee be requested to continue its work at the option of the incoming president.

Final Business Session

Friday, Sept. 15, 1:00 *p. m., Hotel Statler*

President R. A. Bull in the chair.

Announcement was made of the election of officers of the American Foundrymen's Association, Incorporated, to serve the ensuing year:

J. B. Pero, president, Missouri Malleable Iron Co., East St. Louis, Ill.

Benj. D. Fuller, vice president, Westinghouse Electric & Mfg. Co., Cleveland.

A. O. Backert, secretary-treasurer, Penton Publishing Co., Cleveland.

The following resolutions, prepared by the committee composed of S. B. Chadsey, chairman, V. E. Minich and W. B. Robinson, were then submitted and adopted unanimously:

No. 1

Resolved, That the members of the American Foundrymen's Association, Incorporated, do hereby express their most sincere thanks to the Cleveland Convention Committee, and the Chamber of Commerce, for the thorough and able manner in which they have provided for the success of our meetings; to the trade, and daily papers, and to the management of the hotels of Cleveland, for the successful manner in which they have arranged for the details of our entertainment.

That the Association expresses its thanks and appreciation to those who have contributed papers and who have taken part in the discussions at its various sessions.

And Be It Further Resolved, That the Association express to its executive officers its sincere thanks for the signal services they have rendered during the past year, and that we express our full approval of the policy which they followed during that period.

No. 2

Resolved, That the American Foundrymen's Association in convention assembled, express to its officers and executives its sincere thanks for the untiring efforts which they have put forward to make the present educational sessions and exhibition of machinery and equipment the pronounced success which they have proven to be.

That we endorse these officers and executives for the action they have taken in bringing both these branches of the convention under one control, and do hereby congratulate them upon their sturdy stand on behalf of the Association.

Attention was directed to the advisability of the United States Bureau of Standards securing increased appropriations from congress for furthering metallurgical research, since the funds available are inadequate and not commensurate with the needs and prestige of the country, and at the present time are inadequate to meet the requests for tests made by the several government departments.

The following resolution then was submitted and adopted unanimously:

Recognizing that the work being accomplished by the United States Bureau of Standards is of great value, not only to the scientific but also to the commercial interests of our country, the persons present at this meeting of the American Foundrymen's Association, Incorporated, held in Cleveland on this 15th day of September, 1916, most earnestly urge upon the proper national government committees and authorities the supreme importance of proper financial and other support to that bureau, and also request that allied and kindred American scientific and commercial organizations also act in this manner in such ways as in their judgment seem best advised.

The secretary was instructed to transmit a copy of the foregoing resolution to Hon. John. J. Fitzgerald, chairman of the Committee on Appropriations, House of Representatives, Washington, D. C.

The chairman, R. A. Bull, then stated that there was another item of business of a somewhat unpleasant nature, which he stated should be referred to and made a matter of record. "I call your attention to the wording at the top of each preprinted paper," he said. " 'This preprint is subject to correction and modification and is not to be published as a whole or in part pending its formal release by the American Foundrymen's Association through its secretary. It is issued primarily to stimulate written discussion which may be transmitted to the secretary for presentation at the approaching annual meeting to be held at Cleveland, Sept. 11 to 15.' I regret to say that notwithstanding this very plain statement, Rogers, Brown & Co. have published a sheet, wherein are reprinted two of the papers which were submitted for presentation at this convention after possible correction and modification. These two papers I will not mention, but I regret Rogers, Brown & Co. have taken this action and I think my remarks should be made a matter of record to guarantee that this practice be absolutely discontinued".*

*It is due Rogers, Brown & Co. to state that they sincerely regret that any exception was taken to the unauthorized preprinting of A. F. A. papers in the publication issued by them, the circulation of which, we are informed, was limited to 150 copies, of which a great majority were intended for their own people. This explanation given by Rogers, Brown & Co., absolves them from any desire to commit a breach of etiquette.

Following the introduction of the newly elected officers of the American Foundrymen's Association, Incorporated, the proceedings of the twenty-first annual convention of the Association were approved unanimously.

There being no further business the meeting was declared adjourned.

Annual Banquet

Thursday, Sept. 14, 7:00 *p. m., Hotel Statler*

Henry A. Carpenter, General Fire Extinguisher Co., Providence, R. I., presided.

The following addresses were delivered:

"Nation-Building", by Hon. Newton D. Baker, secretary of war, Washington, D. C.

"The Cheerful Yankee", by Irving Bacheller, Riverside, Conn.

Moving pictures of the principal events of the week as well as stereopticon views of the officers and prominent members of the Association, featured the evening's entertainment.

Entertainment Features

The entertainment included free tickets for the ball game, Cleveland versus Detroit, at League Park, Tuesday afternoon, Sept. 12; theater party at Keith's Hippodrome, Tuesday evening; inspection of the Cleveland Furnace Co.'s plant, Wednesday afternoon, Sept. 13, with a trip to Euclid Beach Park in special cars on Wednesday evening.

A luncheon for the ladies was given at the Hotel Statler, Wednesday noon, followed by an automobile sight-seeing trip. All the visiting ladies were favored with bouquets of flowers sent to their rooms immediately following their registration.

Plant visitation was a conspicuous feature of this meeting and included inspection of the following foundries:

Ferro Machine & Foundry Co.,; Interstate Foundry Co.; Westinghouse Electric & Mfg. Co.; West Steel Casting Co.; Allyne-Ryan Foundry Co.; City Foundry Co. and the Best Foundry Co., Bedford, O.

Annual Address

By the President, R. A. Bull

Our organization, during the past two years, has experienced the interesting results on a technical association of hard and prosperous times in the industry to which it is devoted. When we held our convention in Atlantic City, we were beginning to recover from most unsatisfactory conditions in foundry operations, and foundrymen had had abundant opportunity for attention to technical matters not directly connected with their daily routine. In some respects it was a wholesome experience. We were compelled by our predicament to give the closest study to economies, and I venture to say that the efficiency of molding methods, core room practice, and other branches of our work, was improved to greater extent in the years 1914 and 1915 than for many years previously. Foundrymen came to our last convention keen to discuss economy. They had found time to serve on committees and prepare papers, and as a consequence the technical sessions at our last convention were of a very high order.

During the 11 months which have intervened, production in the foundry has increased enormously, and foundrymen have had excessive demands on their time. Increase in production has in many cases been accompanied by labor difficulties. Consequently, the average foundry manager or superintendent has been over-worked and has not received enthusiastically the suggestion to perform duty as a committee member or to write a technical paper. He has not even had opportunity to apply all those theories of efficient production lately evolved, nor has he enjoyed the facilities to keep his keenly observant stockholders and his equally watchful employes happy over their respective shares of the proceeds. Let us hope that he will soon attain that more satisfactory condition of normal demands

from all sources and become again the reasonab' complacent person he is ordinarily. If the pleasures of this vention add to his peace of mind, this meeting will have served a useful purpose, viewed from that standpoint alone. The foundry operator of today needs all the healthy relaxation he can get. Apparently realizing this, the people of Cleveland have most generously and solicitously provided for our comfort and enjoyment, as you will later testify.

I have indicated the difficulty of securing authors of papers. This was not by way of apology for the sessions about to begin. We trust you will find the papers equal in quality to any previously prepared. The total number is greater than at any previous meeting. This has been accomplished through the magnificent support of the Committee on Papers and the authors they have secured. Vice President Swan has directed this committee for the third consecutive year, and has thereby placed us under lasting obligations. And it is pleasing to add that our committees have accomplished much more than might have been expected.

Entry Into New Channels of Endeavor

Your officers have been especially anxious that the sessions of this convention be up to the high standard attained during recent years, so that no one could feel that our technical purpose had failed of attainment because of attention paid by your executives to the business affairs of the Association. Mention of this affords suitable introduction to what I must, for lack of time, restrict my further remarks to on this occasion, namely, a report of the unusual developments experienced by the Association since our 1915 convention. The following summary is given not only as the report of your president, but that of the Executive Board of the unincorporated Association, the Board of Directors of the incorporated Association, the Committee of Five selected to negotiate with the Exhibition company, and the Committee on Exhibits, finally delegated to have charge of our 1916 exhibition. I speak for all of these bodies at their request, and thus supplement the published minutes of their meetings. Your officers feel that every member of the organization is entitled to know the reasons for the breaking of

precedents and the entry of the Association into new channels of endeavor.

Our experiences during the year 1915-16 have been extraordinary, and have required much consideration and effort on the part of several of your representatives. Situations have developed that were not anticipated, calling for numerous conferences and thoughtful action. Those who have shouldered the peculiar responsibilities of this period in our history have earnestly tried to serve the best interests of the Association. The membership must be the judge as to the wisdom of what has been done.

Plan of Co-operation

During my first term of office I was impressed by the advisability of arranging with the Exhibition Company a plan of co-operation which would remove some of the faults attending recent conventions, and which would operate to the joint advantage of the three groups combining to make these meetings successful—the technical organizations, the corporation conducting the exhibition, and the exhibitors at large. It seemed to me entirely feasible to devise a plan which, while yielding a reasonable return on the investment to the few who made up the Exhibition Company, would secure to the technical and most important factor in the annual foundrymen's meetings, what in effect might be regarded as a proper license fee, and at the same time place the great majority of exhibitors holding no stock in the Exhibition Company on a more satisfactory basis. The knowledge that the American Foundrymen's Association had to restrict its technical activities for lack of funds; that the Exhibition Company had primarily not been organized to make large profits, but through its exhibitions to advance the interests of the American Foundrymen's Association; and that, yearly, dissatisfaction was growing and must ultimately cause a change of conditions, was continually confronting many of us. I was further influenced by what seemed to me the excessive dependence of the Association and Exhibition Company on the personalities of their principal officers for the maintenance of harmony.

Trusting in the sense of fairness of all concerned, your president wrote the president and secretary of the Exhibition Company on July 22, 1915, requesting a conference with these

gentlemen, which was held in Chicago on July 25, and at which I frankly submitted my views as previously given, and suggested the execution of a formal agreement of sufficiently flexible, yet permanent form, which would meet the needs of the situation, to be entered into between the respective executive boards. I referred to the important services rendered by the Exhibition Company in the past, the valuable privilege being accorded it by a gratuitous license to conduct an exhibit, and the net results to both organizations and the non-profit-sharing exhibitors. The friendly feeling of our officers toward the Exhibition Company was pointed out and later reflected by comments on co-operation with that company, made in my address at our annual business meeting on Sept. 29, 1915.

First and Second Conferences

Following the first conference, I sent the president of the Exhibition Company on Aug. 11, a tentative form of agreement for criticism. This was debated at a second meeting in Chicago on Aug. 22, attended by your president, Vice President Swan, your secretary, and the president and secretary of the Exhibition Company. After ascertaining at that conference the ideas of the chief executive of the Exhibition Company on what should be included in the agreement, I modified it and sent him on the following day a revised draft, pointing out that it was now redrawn as we had jointly and unofficially agreed, and requesting that he promptly advise if I had correctly phrased our understanding, so that I could submit the proposition to our Board members in time for adoption during the Atlantic City convention. A clause in the agreement specified the conditions to govern the selection of a convention city. It was intended by this means to eliminate friction occasionally attending the settlement of this question.

On Sept. 1, not having had an acknowledgement of the revised agreement submitted Aug. 23, I wrote the president of the Exhibition Company, asking him to inform me at his earliest convenience whether the wording of the agreement conformed with his ideas. He replied on Sept. 8, stating that he had given the matter continuous consideration and favored the idea of an agreement; that details only remained to be

considered; and that he would call a meeting for Sept. 25 or 26 to take action on the matter. On Sept. 14, he wrote me again stating that such a meeting of his directors would be called for Sept. 25 at Atlantic City. I, accordingly, called the annual meeting of our Executive Board for Sept. 27, at the same place.

Appointment of Special Committee of Five

At that meeting I reported what I had undertaken unofficially, read the two agreements which had been prepared, quoted the statement of the president of the Exhibition Company that he thus far had been unable to get his members together for a meeting, and asked for instructions. The importance of the matter had prompted me to issue an urgent summons to this meeting, and the response by 13 members in attendance was gratifying then, and more so later because of what resulted. It was the sense of the members that it would be difficult to have another well-attended meeting of our Board during the convention, and it was contemplated that action on the agreement would be taken before adjournment of the convention. Accordingly, a resolution was adopted without dissent, ordering the appointment of a Committee of Five to consist of the then-incumbent president and secretary and three other members to be selected by the president, to continue negotiations with the Exhibition Company and to have power to act with reference to future co-operation between the two organizations.

Your president sought the president and secretary of the Exhibition Company on several occasions during the following days of the convention, urging that prompt action be taken. The head of the Exhibition Company stated that he had only been able to get personal expressions from a few of the directors, and finally suggested for my consideration, two alternative changes in one clause, which I immediately advised him could not be consistently favored by our committee because of objections which I explained.

Upon the adjournment of the convention, the president of the Exhibition Company requested me to accompany him to Cleveland to investigate the facilities there for our 1916 convention. He stated that his company particularly desired to

decide quickly on the place for the next exhibition. I explained that I could not then conveniently go to Cleveland, and that our Committee of Three, to select the time and place for the next convention, appointed by the Board and consisting of our senior vice president, our secretary and myself, would gladly assist him in expediting the selection, but could not consistently make this decision before disposition was made of the agreement, providing a definite co-operative plan for the selection of a convention city.

Joint Meeting Requested

On Oct. 4 I wrote the president of the Exhibition Company, reminding him of the necessity for prompt action on our agreement, and of his promise to write me on the subject soon after his departure from Atlantic City. I received no reply, nor any further communication from that company, until its secretary wrote me on Oct. 12 advising that he and his president had been to Cleveland and were expecting some information from the Chamber of Commerce there, immediately following the receipt of which the president of the Exhibition Company desired a joint meeting of his committee and ours in Cleveland. I was requested to state when such a meeting would be convenient to our committee, which consisted of our senior vice president, past Presidents Speer and Howell, and the two officers named in the resolution.

I replied on Oct. 13, and wrote the president of the Exhibition Company on the same date, again reminding both officers that propriety required us first to take action on an agreement, and thus have a proper basis for joint action. I referred to the recent published notice that the Exhibition Company had entered the general exhibition field, and said that their company thus, naturally, placed itself in competition with other people experienced in this line. I stated that the interests of, and harmony between, both organizations would be safeguarded by an agreement; also that I was personally opposed to arranging details for the 1916 exhibition until we could in a business-like way have an understanding with the organization which would conduct the exhibition.

The president of the Exhibition Company replied on Oct. 14 stating that I was precipitating a rupture, suggesting that it might be wise for us to arrange with other parties to conduct our exhibit or handle it ourselves, and advising that in that event the Exhibition Company would conduct an independent exhibit, but would place no obstacles in our way. So far as your president knows, this was the first suggestion received or conceived by any member of our committee, that we conduct our own exhibition for 1916. I answered this on Oct. 16, expressing regret and surprise at his letter; referring him to my actions in the past as evidence of my desire for friction or harmony, and requesting that he advise us whether he wished to execute an agreement or continue the former unsatisfactory method of yearly adjusting differences of opinion. The president of the Exhibition Company acknowledged this letter on Oct. 18, not clearly indicating his idea as to executing an agreement and suggesting competition and disaster for us if his company did not conduct our exhibit. I replied on Oct. 19, asking my correspondent to refer to any undesirable features in the last proposed agreement, promising the elimination of such if he could state valid objection. I requested that we be promptly and definitely informed either as to the acceptance of the proposed agreement, its modification as the Exhibition Company might prefer, or the postponement of the matter for that fiscal year. I suggested a conference in Cleveland for Oct. 22 or 23, to be attended by our Committee of Five and representatives of his company, naming as the only condition therefor some disposition of the agreement as the first order of business.

On Oct. 20, I wrote the secretary of the Exhibition Company, to whom I had been sending copies of all my letters to his president. I had been in constant communication with our committee members, and stated that it would be entirely feasible for all of us to be in Cleveland Oct. 23, if I were quickly advised to such effect. I called attention to the fact that his president had had more than two months in which to point out objectionable terms in the agreement, and I expressed dissatisfaction at the way his company had temporized, announcing

that we would take another line of action if we could not soon ascertain what they wanted. I said that in such event the responsibility would rest on themselves.

The secretary of the Exhibition Company wrote me on Oct. 20, that he and his president had regretfully decided it was impossible to assemble their committee on the date suggested; that his president had submitted to his Executive Committee the correspondence with me, and had not had time to ascertain their views; and that they were still awaiting information from the Cleveland Chamber of Commerce. I acknowledged this letter on Oct. 21 and sent a copy to the president of the Exhibition Company. I stated that as several members of our committee would be in Cleveland on Oct. 23, attending the meeting of the American Iron and Steel Institute, that I would go there to confer with them and that I was ready to arrange for a later conference with representatives of the Exhibition Company; I expressed satisfaction that their president had been communicating with his Executive Committee, and offered the opinion that an early decision could be reached.

On the following day I received a letter dated Oct. 20 from the president of the Exhibition Company confirming statements made in his secretary's letter of the same date, and stating that he had made a suggestion to his Board, which, if approved, he would submit to us. I replied on Oct. 22, thanking him for this information, reiterating that our time was restricted as to deciding upon the general plan to be followed for the next convention, and expressing hopefulness for our Association in the regrettable event that our mutual proposition should fail of consummation.

Selection of Cleveland as the Convention City

Our entire committee met in Cleveland on Oct. 23, and conferred with the secretary of the Convention Bureau of the Chamber of Commerce. We learned of methods employed by the Exhibition Company in the consideration of Cleveland as a location for the convention and exhibit, which we regarded as inimical to co-operation. These methods had caused the Convention Bureau to discontinue efforts to have Cleveland

selected as the Foundrymen's convention city for 1916. Your president read to the committee all the correspondence conducted with the Exhibition Company regarding the agreement, also a letter written to him by the president of the American Institute of Metals, empowering the American Foundrymen's Association to act for the Institute in the selection of the time and place for the 1916 Foundrymen's convention. After thorough investigation and discussion, the committee came to the unanimous opinion that all proper efforts to establish co-operation with the Exhibition Company had been made, and that it was inadvisable to cause further delay. Accordingly, a resolution, signed by each member of the Committee of Five, was adopted, and this was ordered published in the technical journals to invite proposals for conducting the 1916 exhibition. Your president was instructed to send copies of this resolution to the president and secretary of the Exhibition Company. Negotiations by your committee were then instituted with the secretary of the Convention Bureau, to whom was read a copy of the resolution. He immediately submitted a proposition that we hold our convention in Cleveland in 1916, and this proposal was accepted.

On Oct. 25 I wrote the president of the Exhibition Company, requesting remittance representing our pre-arranged share of the sum guaranteed by Mr. P. E. Lane, of Atlantic City, for liquidating a portion of the expense of the meeting there, and explained that we wished to have all details of our 1915 convention completed before taking up the matter of the next meeting. The president of the Exhibition Company replied on Oct. 26 that a voucher for the amount due the Association had been mailed by him. On Oct. 27, I replied, acknowledging the remittance, and sending him, by registered mail, a copy of the resolution of Oct. 23, signed by each committee member. I advised him that if his company wished to submit a proposition, according to the terms of the resolution, to conduct the 1916 exhibition, that such exhibition would be held in the city of Cleveland the week of Sept. 11, 1916, and that the general arrangements for such exhibition would be made by the committee signing the resolution. On the same date, I sent the

secretary of the Exhibition Company a copy of the letter to his president, also a copy of the resolution, by registered mail.

On Oct. 28, the head of the Exhibition Company acknowledged receipt of the resolution, advising that the matter would be placed before his Board of Directors. On Nov. 2, the Exhibition Company directors held a meeting in Cleveland, to which our secretary was invited. Representations to him were extended, prejudicial to co-operation. Our resolution was ignored and a new form of agreement was submitted to our representative for his approval. This he refrained from giving, referring the members of the Board to your president. On Nov. 3, I received a telegram from the president of the Exhibition Company, requesting a personal interview in St. Louis for Nov. 4. I telegraphed our secretary, informing him of the message, and requesting him to express to the president and secretary of the Exhibition Company my willingness to grant a personal interview, but my unwillingness to waste further time in an official capacity, after three months consumed in unsatisfactory negotiations.

On Nov. 4, the president and secretary of the Exhibition Company called on me in Granite City, the president explaining that he had not been personally responsible for failure of his Board to reach a decision on co-operation. These gentlemen did not mention our resolution, and tendered a new form of agreement, and I made an appointment with them for a later hour in the day, when our senior vice president joined us. It was the opinion of this officer and myself that the latest form of agreement was not satisfactory, and we unsuccessfully endeavored to have it redrawn in terms more agreeable to the Association, before submission to our committee as a whole. The conference closed by my assurance to the representatives of the Exhibition Company that our committee would promptly pass upon the matter, and by the statement from the head of the Exhibition Company that failure on our part to sign an agreement substantially as then submitted would place us in a defensive position with the Exhibition Company as our energetic opponents. On Nov. 5, I telegraphed the secretary of

the Exhibition Company that our committee would meet at Pittsburgh, Nov. 7, and would be glad to receive there any additional information desired to be given us.

Form of Agreement Disapproved

At our conference in Pittsburgh on Nov. 7, the form of agreement submitted by the Exhibition Company on Nov. 4 was disapproved. It was the sense of the meeting that foundry exhibitions in the future should be under the control of the technical organization; that the exhibitors should share in the profits of the exhibitions in the form of rebates on cost of space; and that our secretary should send each member and past exhibitor an informative letter, which was issued under date of Nov. 8. I telegraphed the president and secretary of the Exhibition Company on Nov. 7, advising each of them that their proposition was not satisfactory to our committee; that we adhered to our resolution of Oct. 23; and that we would be pleased to receive a bid from their company for handling the 1916 exhibition.

On Nov. 8, the president of the Exhibition Company telegraphed me that according to resolutions passed by his entire board, his company only had one alternative—that of conducting an independent exhibit. He added that he would call a Board meeting for a joint conference if desired. I immediately acknowledged this by wire, saying that I appreciated the suggestion for the joint conference, but that I saw no necessity for holding one. On the same date I wrote the president of the Exhibition Company, confirming the telegram sent him.

Some days later a copy of our secretary's letter of Nov. 8, to the members and exhibitors, was mailed by the secretary of the American Institute of Metals to the members thereof.

On Nov. 15, I addressed a letter jointly to the president and secretary of the Exhibition Company, mailing it to Pittsburgh, where I understood the directors of the Exhibition Company would meet the following day. To assure its delivery, I telegraphed the secretary of the Exhibition Company at Chicago that I was sending it, and suggested that it might be of interest to each stockholder in the Exhibition Company. This communication was conciliatory, inviting consideration of

conditions from the standpoint of the technical organizations and outside exhibitors, and expressing the hope that each stockholder in the Exhibition Company as an individual would graciously assist the cause to which all could on the same footing more effectively and harmoniously lend their efforts. My letter was acknowledged on Nov. 20 by the gentleman who was the president of the Exhibition Company, who signed his communication unofficially, and led me to believe that the invited co-operation could not be expected. I confined my acknowledgement on Nov. 22 to affable personal references.

Another Meeting at Pittsburgh

On Dec. 13, I received a telegram from Past President Speer, at Pittsburgh, asking if our special committee would be willing to confer, on Dec. 19, at Cincinnati, with Messrs. Rayner, Munn and Smith, as a committee from the Exhibition Company. This committee had called on our past president asking if a meeting could be arranged. I immediately telegraphed Mr. Rayner that our committee would meet at Pittsburgh on Dec. 19, and would confer with his committee then and there, if desired. Mr. Rayner then telegraphed, thanking me and stating that the appointment was satisfactory. On Dec. 16, Mr. Rayner confirmed his telegram by letter.

On Dec. 19, at Pittsburgh, our entire committee, Messrs. Rayner and Munn, representing the Exhibition Company, and the president of the American Institute of Metals, whom I had invited, held a conference, and after extended and friendly discussion the representatives of the technical organizations unanimously concluded that the Exhibition Company could not adhere to its policies as then declared, and consistently make any proposition for conducting our 1916 exhibition which could be considered satisfactory to ourselves.

Your president, considering that the committee had now performed the duties delegated by the Executive Board, advised it that he would ascertain the wishes of the Board as to further action. Previously, on Nov. 9, and now on Dec. 20, I wrote at length to each Board member, informing him of the status of affairs. On Jan. 4, I addressed a third communication to each member of our Board, reporting on the favorable letter-

ballot I had received from themselves, extending the authority of the Committee of Five. But, believing it advisable, considering the importance of matters in hand, I called a meeting of our Board for Jan. 15, at Cleveland. There were in attendance at this meeting, eight members in person, and the written proxies of four additional members were submitted and approved. All communications from absent Board members were read. A complete summary of events was submitted to those present and they unanimously voted approval of the acts of the Committee of Five, and other representatives of the Association. It was also voted that the 1916 exhibition be under the control of a Committee of Eight, five representing the American Foundrymen's Association, and three representing the exhibitors. It was, however, decided to exclude from this committee's authority the disbursement of the net proceeds of the exhibition, it being considered proper that the Executive Board of the American Foundrymen's Association should make equitable distribution of these proceeds. The Committee on Exhibits was given authority to engage a Manager of Exhibits, and to make all other business arrangements for the exhibition.

The Exhibition Committee

Messrs. H. S. Covey, of Cleveland, S. T. Johnston, of Chicago, and V. E. Minich, of New York, were selected by the Board to represent the exhibitors on the Committee of Eight, and Messrs. Pero, Backert, Speer, Howell and Bull, who had constituted the Committee of Five on Co-operation, were named by the Board to represent the Association on this new committee.

On Jan. 27, by authority of the Committee on Exhibits, your president wrote Mr. C. E. Hoyt, inviting him to submit a proposition to manage the 1916 exhibition, and this resulted in the engagement of Mr. Hoyt's services on Feb. 27. Prior to this Mr. Hoyt had tendered his resignation as secretary of the Exhibition Company. The corporation's contract with our Manager of Exhibits covers no indefinte period, but simply the 1916 exhibition. The Committee on Exhibits has its powers similarly restricted.

On Feb. 25, the present secretary of the Exhibition Company wrote me that new officers had been elected by his company, which had decided not to conduct any exhibition in 1916, unless it be by our invitation. He said they would be glad to advise under what conditions they would conduct our exhibition if we wished to consider this, and informed me that no offense would be taken if the proposition did not appeal to us. I replied on March 1, advising that we had already made definite arrangements for the conduct of our 1916 exhibition, having engaged Mr. Hoyt to manage it. I expressed appreciation for the friendly assurances and said that we would reciprocate in kind. On March 3, my correspondent replied, wishing us success, and assuring us of any support that the Exhibition Company could give.

Your president hereby frankly and gratefully admits the fulfillment of this promise as indicated by the fact that three-fourths of the exhibiting members of the Exhibition Company are among the occupants of space at the Wigmore Coliseum and Annex. This is a manifestation of a generous, sportsmanlike spirit which should make a strong appeal to our members, and cement the friendships formed at the gatherings. To all who have participated in the management of these foundry exhibitions in the past, we owe our thanks, and your president takes it upon himself now to extend it to each of these gentlemen, and to hope for his future regard. As time passes, conditions change and methods must conform, or fail of their purpose. Transformation in human affairs as in nature is variously perceived from different angles of vision, and it is neither safe nor charitable to consider as hopelessly defective in vision the observer whose view has been restricted by his environment.

Recognition of the American Foundrymen's Association as an acceptable controlling element at this time in these foundry exhibitions is best illustrated by the fact that this year there are more exhibitors than at any previous foundrymen's convention. Such approval and co-operation are appreciated in the highest degree by those who are endeavoring to create conditions satisfactory to all.

I have purposely gone into detail in my preceding explanation, only to give the members of this Association a connected,

abridged history of events. Specific reference has been made to every official communication and interview which had a part in our negotiations with the Exhibition Company. I ask that the complete original correspondence on this matter in my possession, be placed in the permanent files of the Association.

Incorporation of Association

Events which have transpired since the engagement of our Manager of Exhibits, are matters of common knowledge, and require no detailed explanation other than mention of the incorporation of the Association. The decision to place the 1916 exhibition under the control of the Association, prompted your president to suggest in a letter written Jan. 4 to all Board members, that the Association be incorporated. After a thorough discussion, following legal investigation, the following resolutions were unanimously adopted at the meeting of the Executive Board held in Cleveland, Jan. 15, 1916:

Whereas, The American Foundrymen's Association has heretofore in contracting with other parties, and in its other business transactions, acted through its officers and Executive Board, and has thereby caused the officers and members of the Executive Board to assume a liability unfair to them, and

Whereas, The members of the American Foundrymen's Association are now liable upon the engagements of said Association as partners and without a fixed or limited liability, and

Whereas, It is the sense of this body that its business can be transacted more efficiently if incorporated, and the liability of the individual members eliminated,

Therefore, Be It Resolved, That the Executive Board forthwith employ legal counsel for the purpose of properly incorporating under the name of The American Foundrymen's Association, Incorporated, or such other similar name as may be found practical under all circumstances, and the purpose for which said organization is organized is to promote the arts and sciences connected with the manufacture of castings of any metal and the education, welfare and social intercourse of those engaged in the foundry industry, by the collection and dissemination of all proper information relating to the above and by the reading and discussion of professional papers and the publication of same; to secure an exchange of experiences and uniformity of practices among foundrymen; and for the furtherance of the objects noted above, to hold annual conventions at which exhibitions of equipment and supplies of interest to foundry operators shall be maintained.

And Be It Further Resolved, That said Executive Committee expend, and it is hereby authorized to expend, such amount in perfecting and organizing said corporation as the committee may deem necessary.

Immediately following the session at which these resolutions were unanimously adopted, a preliminary meeting was held to organize the American Foundrymen's Association, Incorporated, those present being all members of the Executive Board of the Association who had attended the Board meeting just adjourned. Your president and secretary, respectively, were chosen as temporary chairman and temporary secretary. Steps were taken to engage an attorney to prepare and file Articles of Incorporation and to assist in drafting By-Laws. Following this organization meeting, the temporary officers investigated the rights and privileges of corporations not organized for profit, both in Illinois and Ohio, and at a subsequent meeting of the temporary organization held in Pittsburgh, Feb. 27, the decision to incorporate in Illinois, not for profit, was reached, because of more favorable regulations in that state. It was decided to invite all members of the Executive Board of the Association, all honorary members of the Association, the Manager selected for the 1916 exhibition, and the members of the Committee on Exhibits, to serve as incorporators. This plan could not in its entirety be carried out, as the Illinois statutes require that all incorporators shall be citizens of the United States. Others may, however, become members of the corporation. To our regret, Past President Anthes, Vice President Chadsey and Prof. Turner, honorary members, could not, because of their nationality, sign the Articles of Incorporation. Vice President Field preferred not to do so. With the exception of these four gentlemen, all living past presidents, all honorary members, all persons now holding office in the Association, the Manager of our 1916 exhibition, and the exhibitors' representatives on our Committee on Exhibits for this year, have their signatures attested by notaries, attached to the Articles of Incorporation, which are filed in the office of the Recorder of Cook County, Illinois. It is interesting to know that these incorporators, 27 in number, include the following gentlemen who have in the past rendered inestimable service to our organization: Past Presidents Seaman, Jones, Walker, Brown, Wolff, McFadden, Flagg, Waterfall, Speer, Miles and Howell; and Past Secretaries Penton and Moldenke. This is an imposing list, and affords pleasing proof of the confidence of your former executives in the

judgment of your present Board, whose members are duly appreciative. The charter was granted to the American Foundrymen's Association, Incorporated, on July 3, 1916—practically six months after the organization meeting of prospective incorporators was held.

Amalgamating the Incorporated and Unincorporated Bodies

It now remains to amalgamate the two Associations into one. No member of the unincorporated Association who expresses his preference not to join the corporation can be forced into that body. We have been creating the membership of the corporation through the desire of individual members, expressed in writing. You have seen the circular letter from the secretary to all members, dated Aug. 16, bearing on this matter, and have probably read the By-Laws enclosed with that letter. Certain features of these By-Laws should be explained for your information.

The object of the corporation is stated in such terms as to very clearly indicate the technical and educational nature of the organization. In this a change has been made, as the phraseology of the old Constitution was so broad as to indicate a possible commercial purpose.

In conformity with the statutes, such a corporation as ours must be composed exclusively of individuals as members; therefore, firms or corporations must indicate the names of representatives who will nominally be known as holding memberships individually.

A change has been made in the privileges of associate members, it being the sense of the directors that this Association should more closely conform to the practice of similar organizations in this respect, and the reasons for making such distinctions appear sound.

The old Executive Board has been elastic, including all past presidents. The corporation was required to have a fixed number of directors stipulated in the Articles of Incorporation. It was decided to designate that there should be 16 directors, all to be elected annually by and from the active and honorary members. It being the procedure of corporations to have their directors elect their executive officers, provision

for such action has been made. In order to secure the continued interest of former executives whose continued assistance has been of such great value, an Advisory Board has been created, composed of all past presidents and honorary members, excepting those who may be elected to the directorate.

In naming the directors for the first year, as required when we filed our Articles of Incorporation, it was contemplated that each director should tender his resignation at this convention, and that the members of the corporation at this convention should elect the persons desired to serve as directors.

The By-Laws

The section of the By-Laws under the head of amendments is more liberal as to the rights of the Board, than was the case formerly. An inherent right of directors of a corporation is that of amending By-Laws at any regular or properly called meeting of the Board, and a By-Law cannot legally be written denying this privilege. The original provision for the modification of By-Laws by the members remains as before.

With this explanation it is hoped the members will feel that the By-Laws are satisfactorily drafted. Considerable thought was given this matter, first by a committee consisting of your president, senior vice president, Vice Presidents Janssen and Swan, and your secretary. This committee conferred in person with our attorney in Chicago on July 30, and later at a meeting of the directors called for this purpose in Cleveland on Aug. 6, attended in person by 12 of the 16 directors, the By-Laws were formally adopted.

It will be apparent from all that I have said, that the Association, during the 12 months now ending, has undertaken matters of unusual importance. It is the hope of your officers that you will feel there was proper justification for all that has been done, and that the interests, not only of the Association, but of all who help to make these annual foundry meetings successful, have been served.

Your president naturally feels a particular pleasure in relinquishing office with the organization seemingly well-started on lines of greater usefulness. He takes no credit for any especial part in what has been done to make this possible,

but admits the responsibility for instituting negotiations which culminated in events of great importance. He seriously felt the constant need of wise counsel, and invariably received it from the other zealous and far-sighted members of our Committee of Five, to whom he feels you owe a great deal. He cannot express his deep gratitude for the indefatigable co-operation of the other members of that committee, and only in lesser degree to the exhibitors who enlarged it to a Committee of Eight, delegated to have charge of the 1916 convention. He is greatly indebted to the members of the Board who have maintained a very active interest and given wholesome advice; and especially to your senior vice president and your secretary-treasurer, without whose tireless efforts much could not have been accomplished. To the many who have helped to advance the Association in countless ways during my tenure of office, I feel under obligations which can never be repaid. The congenial fellowship of my colleagues has made the performance of my duties a privilege.

I look forward with the keenest anticipation to the maintenance of the friendships I have formed in our Association activities no less than to the greater development and usefulness of the organization along technical lines. I am impressed by the thought that this, our twenty-first birthday (as it can be truthfully regarded), marks the enterprise of youth and that the future will quickly develop the vigor and service of maturity. There should result to the Association, through the proper conduct of our exhibitions, the co-operation which will guarantee its highest success, and the means which will enable it to conduct research work and committee activities that were impossible in the past. Very soon, as I believe, the privilege of membership in the American Foundrymen's Association will be universally claimed by progressive foundrymen engaged not only in the manufacture of gray iron, malleable iron and steel, but of all metals, as contemplated in the By-Laws.

Annual Report of the Executive Board

To the Members of the American Foundrymen's Association:

Negotiations leading up to and following the decision to assume the control and management of the Cleveland exhibition of foundry supplies and equipment and machine tools and accessories, and the necessary preliminaries preceding the incorporation of your Association, as well as the organization after the granting of the charter, rounded out a year of unusual activity for the members of your Executive Board. Three meetings of your Board were held, as follows: Sept. 27 and Oct. 1, 1915, at Atlantic City, and Jan. 15, 1916, at Cleveland, the latter having been divided into three sessions. However, your president, senior-vice president and secretary-treasurer, including some of the members of your Board, served on the Special Committee of five appointed at Atlantic City, Sept. 27, on the Exhibition Committee and took part in the incorporation of your Association. The Special Committee of five held three meetings, Oct. 23, Nov. 7 and Dec. 19, 1915; the Exhibition Committee held two meetings, Feb. 27 and June 24, 1916, and the preliminaries leading to the incorporation and the organization of the American Foundrymen's Association, incorporated, were effected at three meetings, namely Jan. 15, Feb. 27 and Aug. 6, 1916. All of the meetings were exceptionally well attended and reflected the great interest manifested in the affairs of your Association by the members of your Executive Board. Each of these meetings of the Special Committee of five was attended by every member and in addition to the foregoing, a committee to draft the By-laws of the American Foundrymen's Association, incorporated, met in Chicago, July 30, 1916. Since all of the members of your Board are men of large affairs, whose duties were multiplied by the unusual activity prevailing in the foundry trade and its accompanying labor difficulties, their attendance at these numerous gatherings frequently involved great business and personal sacrifice and inconvenience. To familiarize all of the members of the Associa-

tion with the transactions of these meetings, the minutes, herewith, are presented in full. The proceedings of the annual business meeting, held at the Hotel Traymore, Atlantic City, Sept. 29, are included, as they have a direct bearing upon the subsequent action taken.

Respectfully submitted,

R. A. BULL, Chairman.

A. O. BACKERT, Secretary.

Executive Board of the American Foundrymen's Association.

Minutes of the Meetings of the Executive Board

ANNUAL MEETING OF THE EXECUTIVE BOARD, HELD AT THE NORTHFIELD COUNTRY CLUB, ATLANTIC CITY, N. J., MONDAY, SEPT. 27, 1915.

The annual meeting of the Executive Board of the American Foundrymen's Association, held at the Northfield Country Club, Atlantic City, N. J., Monday evening, Sept. 27, 1915, was called to order by President R. A. Bull, with the following in attendance:

R. A. Bull, Commonwealth Steel Co., Granite City, Ill.
A. O. Backert, Penton Publishing Co., Cleveland.
J. S. Seaman, Seaman-Sleeth Co., Pittsburgh.
L. L. Anthes, Anthes Foundry Co., Ltd., Toronto.
Major Jos. T. Speer, Pittsburgh Valve Foundry & Construction Co., Pittsburgh.
A. E. Howell, Phillips & Buttorff Mfg. Co., Nashville, Tenn.
H. E. Field, Wheeling Mold & Foundry Co., Wheeling, W. Va.
H. A. Carpenter, General Fire Extinguisher Co., Providence, R. I.
Alex T. Drysdale, U. S. Cast Iron Pipe & Foundry Co., Burlington, N. J.
B. D. Fuller, Westinghouse Electric & Mfg. Co., Cleveland.
J. P. Pero, Missouri Malleable Iron Co., East St. Louis, Ill.
J. J. Wilson, Cadillac Motor Car Co., Detroit, Mich.
Walter Wood, R. D. Wood & Co., Philadelphia.

The affairs of the Association were discussed at length, particularly the relations existing between the American Foundrymen's Association and the Foundry & Machine Exhibition Co. President R. A. Bull detailed at length his interviews with F. N. Perkins, president, and C. E. Hoyt, secretary, of the Foundry & Machine Exhibition Co., with reference to the suggested working agreement

between these two organizations, which would define clearly the requirements of each, the fixing of the annual meeting place and other features relating to the conventions of the American Foundrymen's Association and the exhibition of the Foundry & Machine Exhibition Co.

While it was reported to the president, R. A. Bull, by F. N. Perkins, president of the Foundry & Machine Exhibition Co., that a meeting of the Executive Board of the Foundry & Machine Exhibition Co., would be held at Atlantic City, Saturday, Sept. 25, for the purpose of considering a proposed form of agreement between the American Foundrymen's Association and the Foundry & Machine Exhibition Co., no such meeting was held, President R. A. Bull having been advised by F. N. Perkins that it was impossible to get the directors of his company together on that date.

Inasmuch as it was believed practically impossible to hold another meeting of the Executive Board of the American Foundrymen's Association during the week of the convention at Atlantic City, it was suggested that a special committee of five, consisting of the president, the secretary and three other members, to be appointed by the president, should be named, with full power to act.

Upon motion by H. A. Carpenter, which was duly seconded, the following resolution was adopted without dissent:

> *Whereas,* It is deemed advisable to continue the negotiations undertaken by President R. A. Bull with F. N. Perkins, president of the Foundry & Machine Exhibition Co., therefore,
>
> *Be it resolved,* That a special committee of five be appointed to consist of the then incumbent president and the secretary of the American Foundrymen's Association and three other members to be appointed by the president, this committee to have full power to act with reference to future co-operation with the Foundry & Machine Exhibition Co.

The president later announced the appointment of the three other members of this committee, consisting of Major Jos. T. Speer, Pittsburgh Valve Foundry & Construction Co., Pittsburgh; A. E. Howell, Phillips & Buttorff Mfg. Co., Nashville, Tenn., and J. P. Pero, Missouri Malleable Iron Co., East St. Louis, Ill.

The secretary then was instructed to leave the meeting and it was decided to recommend to the Association, at its business meeting to be held at the Hotel Traymore, Wednesday evening, Sept. 29, that the salary of the secretary-treasurer be increased from $1200 to $1800 per year.

There being no further business, the meeting adjourned.

R. A. Bull, President.

A. O. Backert, Secretary.

ANNUAL BUSINESS MEETING OF THE AMERICAN FOUNDRYMEN'S ASSOCIATION, HELD AT THE HOTEL TRAYMORE, ATLANTIC CITY, N. J., WEDNESDAY, EVENING, SEPT. 29, 1915.

The first order of business was the presentation of the annual address by the president, R. A. Bull, which, since the meeting, has been printed and distributed to the members.

This report contained the following suggestions:

> "To more satisfactorily establish the relations between that company and your association, I recommend that you authorize your Board to make such arrangements governing future co-operation with that representing the Exhibition Co., as may seem advisable.
>
> "This co-operative work augurs well for the greater usefulness of our body and could, perhaps, be introduced advantageously into our safety propaganda by collaboration with the Conference Board on Safety and Sanitation, now representing the National Founders' Association, the National Association of Manufacturers, the National Metal Trades Association, and the National Electric Light Association. Such co-operation, I am assured, would be welcomed by the organizations now joining forces in advocating Safety First, and the prorated yearly expense which would be borne by our body, estimated at $350 a year, and restricted to a maximum amount of $500 annually, would, in my opinion, be justified at least for one year's experiment as soon as the state of our treasury permits.
>
> "It has been suggested by the National Founders' Association that we co-operate with that body, the National Metal Trades Association, the National Association of Manufacturers, and the United Typothetae of America in the joint conference board on industrial education. The expense to each organization affiliated is now $100 per annum. There is some difference of opinion with respect to the methods to be pursued in furthering industrial training which, in the abstract, all progressive persons wish to encourage. And whether it may or may not seem best to the association that this organization join in the activities of the Conference Board, the knowledge that our participation is courteously invited is pleasing, as one of the many instances of the esteem in which this association is held by others. I advise serious consideration of this matter by the incoming Board.
>
> "I have received, and submitted to the Board, several proposals from commercial laboratories which hold membership in the Association and which would be pleased to be designated as its official chemist, and as such to make investigations and determinations for this body, in return for the prestige attaching to the appointment. In my judgment, an official chemist should be named when, but not before, there are assured facilities for systematic research work by a reasonable

number of committees. It would be enlightening for the members to express their views on this matter, which, following some discussion, should, I think, be referred to the Board with power to act when the time is deemed propitious.

"The situation existing with regard to local foundrymen's organizations in several large centers, together with the need for closer relations between our body and its individual members, should make us consider if we may not soon apply the method of having local sections, which has met with much success in several engineering and scientific societies. Your president is aware of several local organizations of foundrymen which are having indifferent success. I offer for your future consideration, the suggestion that we ascertain the attitude of the various localized groups of foundrymen toward the idea of merging into local sections of the American Foundrymen's Association. This action, it would seem to me, would redound to the greater and better influence of centralized groups and of the parent body. In voicing this opinion, I do not detract in the least from the very great usefulness and healthy condition of foundry organizations found in some of our cities. A necessary feature of this plan involves some financial and other aid from the national organization, whose ability to provide such is materially assisted by the larger membership resulting."

The report of the secretary-treasurer, A. O. Backert, then was submitted as well as that of the auditors, Ernst & Ernst, Cleveland. Both of these reports were distributed in pamphlet form to all the members.

The report of the Executive Board was submitted by the secretary, A. O. Backert, and this report, as well as that of the secretary-treasurer and the auditors, Ernst & Ernst, was unanimously adopted.

Resolutions on the deaths of Thos. D. West and E. H. Mumford, presented by Richard Moldenke, chairman of this special committee, were adopted by a rising vote.

The report of the nominating committee, consisting of J. S. Seaman, L. L. Anthes, Henry A. Carpenter, A. E. Howell and Major Jos. T. Speer, was presented and contained the following recommendations for officers for the coming year:

President, R. A. Bull, Commonwealth Steel Co., Granite City, Ill.

Senior vice president, J. P. Pero, Missouri Malleable Iron Co., East St. Louis, Ill.

Vice Presidents

Henry A. Carpenter, General Fire Extinguisher Co., Providence, R. I.

S. B. Chadsey, Massey-Harris Co., Ltd., Toronto.

Alex. T. Drysdale, U. S. Cast Iron Pipe & Foundry Co., Burlington, N. J.

H. E. Field, Wheeling Mold & Foundry Co., Wheeling, W. Va.

B. D. Fuller, Westinghouse Electric & Mfg. Co., Cleveland.
W. A. Janssen, Bettendorf Co., Davenport, Ia.
H. B. Swan, Cadillac Motor Car Co., Detroit.
A. H. Thomas, Buckeye Steel Castings Co., Columbus, O.
Walter Wood, R. D. Wood & Co., Philadelphia.
Secretary-treasurer, A. O. Backert, Cleveland.

Upon motion, duly seconded, the report of the nominating committee was adopted and the secretary was instructed to cast the ballot.

J. S. Seaman moved that the salary of the secretary-treasurer be increased from $1200 to $1800 per year, dating from Oct. 1, 1915. This motion was duly seconded and unanimously adopted.

J. S. Seaman moved the election of President R. A. Bull to honorary membership in the American Foundrymen's Association, and after being duly seconded, the motion was adopted unanimously.

W. H. Barr, president of the National Founders' Association, spoke at length on the joint work that is being done by the National Founders' Association, the National Association of Manufacturers, the National Metal Trades Association and the National Electric Light Association, which entails a cost for each organization of from $350 to $500 per year. A hearty invitation was extended the American Foundrymen's Association to affiliate with this body, which is known as the "Naso Board".

Chairman R. A. Bull then made the following suggestions:

"I would like to recommend as an appropriate thing to do in the matter of the suggestions that have been made concerning all points touched upon by myself, Mr. Barr and other speakers, that they be referred to our Executive Board with power to take whatever action may be deemed advisable. That would really be according to the regulations of the constitution, but it would not be out of place to make it a matter of record at this session, I think."

A. E. Howell, of the Phillips & Buttorff Mfg. Co., Nashville, Tenn., then presented a motion which was duly seconded and unanimously adopted, that the matters suggested in the papers and discussions here this evening be referred to the Executive Board with power to act.

W. H. Barr, president of the National Founders' Association, in discussing co-operation with the National Founders' Association, stated that he could conceive of no objection on the part of the Council of the National Founders' Association to sending out to the members of their organization, reports issued by the American Foundrymen's Association's Cost Committee, containing its suggestions, with an appropriate letter urging members of the National Founders' Association to assist in this plan, if we desire to have them do so.

The chairman stated that the matter of conference and co-operation might be satisfactorily worked out with the approval of both organizations after reflection and consideration of the subject.

After a brief discussion of affiliation of local associations with the American Foundrymen's Association, the meeting adjourned.

R. A. Bull, Chairman.

A. O. Backert, Secretary.

Meeting of the Executive Board of the American Foundrymen's Association, Young's Pier, Atlantic City, N. J., Friday, Oct. 1, 1915.

Immediately following the adjournment of the Atlantic City convention, a meeting of the Executive Board of the American Foundrymen's Association was held on Young's Pier, which was attended by the following:

R. A. Bull, president, Commonwealth Steel Co., Granite City, Ill.
J. P. Pero, senior vice president, Missouri Malleable Iron Co., East St. Louis, Ill.
Major Jos. T. Speer, Pittsburgh Valve Foundry & Construction Co., Pittsburgh.
J. S. Seaman, Seaman-Sleeth Co., Pittsburgh.
B. D. Fuller, Westinghouse Electric & Mfg. Co., Cleveland.
W. A. Janssen, Bettendorf Co., Davenport, Ia.
A. O. Backert, secretary-treasurer, Cleveland.

The numerous suggestions contained in the annual address of the president, R. A. Bull, were considered at length and it was decided to empower a special committee of three, consisting of the president, senior vice president and secretary-treasurer, to act on behalf of the Executive Board as well as the Special Committee of five appointed at the Northfield Country Club, on Monday evening, Sept 27, which was appointed with full power to act in the negotiations under way with the Exhibition Co.

The question of expenditures for committees for the ensuing year also was considered and this matter was left in the hands of a committee, consisting of the president, senior vice president and secretary-treasurer, with full power to act, with the proviso that the expenditures for this purpose should not exceed $500, exclusive of the expenses incurred by the committee on papers.

The secretary also reported a number of delinquents to whom an extension of time already had been granted to afford them an opportunity to pay their back dues before dropping their names

from the membership rolls, and the following resolution was unanimously adopted:

> *Resolved,* That the time for the payment of delinquent 1914-1915 dues for membership be extended to Dec. 1, 1915. Those who still remain delinquent on and after that date shall have their names published in the Transactions of the American Foundrymen's Association as being delinquent, and as having been dropped from membership for this cause. The names of those delinquent on Dec. 1, 1915, shall be stricken from the rolls of our Society.

There being no further business, the meeting adjourned.

R. A. Bull, President.

A. O. Backert, Secretary.

Meeting of the Executive Board of the American Foundrymen's Association, Hotel Statler, Cleveland, Jan. 15, 1916.

Morning Session

The meeting of the Executive Board of the American Foundrymen's Association, held at the Hotel Statler, Cleveland, Jan. 15, 1916, was called to order at 10:30 a. m., with President R. A. Bull in the chair.

The following were in attendance:

R. A. Bull, Commonwealth Steel Co., Granite City, Ill.
Major Jos. T. Speer, Pittsburgh Valve Foundry & Construction Co., Pittsburgh.
Alfred E. Howell, Phillips & Buttorff Mfg. Co., Nashville, Tenn.
J. P. Pero, Missouri Malleable Iron Co., East St. Louis, Ill.
S. B. Chadsey, Massey-Harris Co., Ltd., Toronto.
B. D. Fuller, Westinghouse Electric & Mfg. Co., Cleveland.
H. B. Swan, Cadillac Motor Car Co., Detroit.
A. O. Backert, Cleveland.

The minutes of the following meetings were read and approved:

Annual meeting, Executive Board, Northfield Country Club, Atlantic City, Sept. 27, 1915.

Annual business meeting of the American Foundrymen's Association, Hotel Traymore, Atlantic City, Sept. 29, 1915.

Meeting of the Executive Board, Young's Million Dollar Pier, Atlantic City, Oct. 1, 1915.

Meeting of the Special Committee of Five, Hollenden Hotel, Cleveland, Oct. 23, 1915.

Meeting of the Special Committee of Five, Fort Pitt Hotel, Pittsburgh, Nov. 7, 1915.

Meeting of the Special Committee of Five, Anderson Hotel, Pittsburgh, Dec. 19, 1915.

It was moved by J. P. Pero and seconded by Major Jos. T. Speer that the right of proxy voting be permitted at this meeting. This motion was carried unanimously.

Authority was given the president, R. A. Bull, to cast their votes in their absence by the following members of the Executive Board: Alex. T. Drysdale, W. A. Janssen, L. L. Anthes and A. W. Walker. The letters addressed to the president, R. A. Bull, containing these proxies are herewith attached and form a part of the minutes of this meeting.

A letter from H. E. Field, Wheeling Mold & Foundry Co., Wheeling, W. Va., to President R. A. Bull, dated Nov. 22, 1915, and Mr. Bull's reply, dated Nov. 24, 1915, were read and are incorporated in these minutes.

A letter received from Henry A. Carpenter General Fire Extinguisher Co., Providence, R. I., a member of the Executive Board, also was read and forms a part of these minutes.

A motion was offered by H. B. Swan, which was seconded by B. D. Fuller, that the Executive Board approve of the acts of the Special Committee of five and all actions taken up to the date of this meeting. This motion was carried without dissent.

A motion was made by J. P. Pero and seconded by Major Jos. T. Speer, that it is the sentiment of this meeting that the American Foundrymen's Association should be an incorporated body and that legal advice should be secured looking towards such incorporation. This motion was carried without dissent.

The following resolution then was adopted unanimously:

> *Whereas,* The American Foundrymen's Association has heretofore, in contracting with other parties, and in its other business transactions, acted through its officers and Executive Board, and has thereby caused the officers and members of the Executive Board to assume a personal liability unfair to them, and
>
> *Whereas,* The members of the American Foundrymen's Association are now liable upon the engagements of said association as partners and without a fixed or limited liability, and
>
> *Whereas,* It is the sense of this body that its business can be transacted more efficiently if incorporated, and the liability of the individual members eliminated, therefore
>
> *Be it resolved,* That the Executive Board forthwith employ legal counsel for the purpose of properly incorporating under the name of the American Foundrymen's Association, incorporated, or such other similar name as may be found practical under all the circumstances, and the purpose for which said corporation is organized is to promote the arts and sciences connected with the manufacture of castings of any metal, and the education, welfare and social intercourse of those engaged in the foundry industry, by the collection and dissemination of all proper information relating to the above and by the reading and discussion of professional papers and the publications of the same; to secure an exchange of experiences and uniformity of practices among foundrymen; and for the furtherance of the objects noted

above, to hold annual conventions at which exhibitions of equipment and supplies of interest to foundry operators shall be maintained, and

Be it further resolved, That said Executive Board expend, and it is hereby authorized to expend, such amount in perfecting and organizing said corporation as the Board may deem necessary.

There being no further business, the meeting adjourned.

R. A. BULL, President.

A. O. BACKERT, Secretary.

The following letters constitute a part of the minutes of the morning session of the meeting of the Executive Board, held at the Hotel Statler, Cleveland, Jan. 15, 1916:

Providence, R. I., Jan. 11, 1916.

R. A. Bull, President,
American Foundrymen's Association,
Granite City, Ill.

Dear Sir:—

The writer has delayed answering your letter of Jan. 4, to the Executive Board, until it was finally determined if it would be possible for me to be present at the Board meeting on Jan. 15 I find out today that it will be impossible for me to be in attend ance. I realize full well that it will be an important meeting and that we have a business proposition of no small degree to consider. I have just learned this afternoon of another meeting in New York City which will require my attendance and will absolutely prevent my going to Cleveland.

I have read over your suggestions, regarding some of the important matters to be considered, but as the discussion at the conference may bring out other valuable suggestions, I consider that it would be unwise for me to attempt to express myself upon the different matters, for fear of handicapping the Board in its action. I have every confidence that whatever action is taken at the meeting, will be for the best interests of all concerned, and am perfectly willing to leave the matter entirely in the hands of those members of the Executive Board who may be in attendance.

Regretting my inability to be with you, with kind regards and a hearty "Cheero", I am,

Sincerely yours,
Henry A. Carpenter,
Vice President.

Boston, Mass., Jan. 7, 1916.

R. A. Bull, President,
American Foundrymen's Association,
Granite City, Ill.

My Dear Sir:—

I thank you for your valued favor of the 4th, and I note that you have called a meeting of the general committee at Cleveland a week from tomorrow and I note you say that expenses will be paid under a recent vote.

Now I have to come quite a long way and I doubt whether I am worth, at this meeting, the amount of my expenses.

I would like *not* to come, although I cannot say that I have any appointments for the 15th or the days before or after, which would make it impossible for me to come.

The matters you are to talk about are, it seems to me, just as well arranged in a small meeting of those who know the case well, and, as for me, if I can find out what the president wants, I will back him up every time.

I would be very glad to place my proxy in your hands, and hereby do so; and now that you know that all I should do is to agree with you, is it worth forty or fifty dollars to the Association, and the wear and tear on me, for me to be personally present?

Very truly yours,

A. W. Walker.

Burlington, N. J., Jan. 10, 1916.

R. A. Bull, President,
American Foundrymen's Association,
Granite City, Ill.

Dear Mr. Bull:—

Replying to your letter of the 4th inst., I agree with Mr. Carpenter in regard to putting some limit on the expenditures which might be made by the committee having the exhibit in charge. This exhibit is going to be an experiment and the financial result is in doubt, so that Mr. Carpenter's point is well taken.

As I will not be able to be present with you on the 15th I hereby appoint you my proxy to vote for me on the questions to be considered on that date. In case you are not permitted so to act, will you kindly ask Mr. Howell to act for me.

Regarding Mr. Backert's suggestions, I believe the technical and exhibition branches should have a separate account, but have the same treasurer.

In your letter of December 20, we were asked to confer authority on the committee of five to conduct the next exhibition, and the authority was given, according to your letter of the 4th inst. Mr. Backert's suggestion is that this committee be reduced to three with the addition of the Exhibition Manager and three representatives of exhibitors. I believe this would be a better arrangement and suggest the change.

The three representatives from the exhibitors should be appointed by the officers and manager of the association in order to have a harmonious committee.

While I am in favor of a per diem allowance being made the officers and representatives when attending meetings for the purpose of discussing exhibition affairs, I think an allowance of $10.00 a day and traveling expenses would be ample, particularly this first year, as noted in a previous paragraph of this letter—except that the Manager and Secretary would be allowed the traveling expenses only.

I do not see why the president should not accept his per diem allowance, as all he has done has met with the hearty approval of the Board.

Your idea of incorporating the Association is a good one and it should be done.

Regretting that I cannot be with you on the 15th and trusting you will be able to report Mr. Hoyt's acceptance as Manager, I remain,

Very truly yours,

Alex. T. Drysdale.

Toronto, Jan. 14, 1916.

R. A. Bull, President,
American Foundrymen's Association,
Cleveland, Ohio.

Dear Sir:—

You must overlook my remissness in not giving your correspondence the proper attention, but stock-taking, preparation of annual reports, military duties, etc., have somewhat disturbed my regular routine.

As I have charge of a school of instruction in Military Engineering here, I will be unable to be with you tomorrow, 'though at first I thought that I might be able to arrange it. I can appreciate the importance of the gathering, as the handling of an exhibit is certainly a big responsibility and all details connected therewith very important. It is going to mean considerable work for somebody, and I believe that you, personally, will have to shoulder no small portion of it. If it is possible to secure Mr. Hoyt, you will be starting off under more favorable circumstances than if you had to rely on someone less experienced. While I am sorry to see the necessity of the A. F. A. handling its own exhibit, I am ready to support the Executive Board now that it is committed to the step, as I know that yourself and other members of the Executive Board have given the matter considerable thought and time and have at all times had the best interests of our Association at heart.

I delegate to you the power to vote on my behalf, being assured that you will exercise both good judgment and discretion.

Wishing you every success and conveying to the other members of the Executive Board my sincere regards, believe me,

Yours truly,

L. L. Anthes.

Davenport, Iowa, Jan. 7, 1916.

R. A. Bull, President,
American Foundrymen's Association,
Granite City, Ill.

My Dear Mr. Bull:—

I very much regret my inability to be present at the meeting of the Executive Board in Cleveland next week. Rushed production, together with new construction and fighting the grippe makes my absence imperative.

Being practically a novice, I know so little of the inner workings of the past relations with the American Foundrymen's Association and the Exhibition Co., all of which, however, might be waived and the matter reverted to the fundamental principle of the exhibition and its relation to the foundrymen's convention. Fundamentally it is an opportunity for exhibitors to present for consideration and inspection of the foundrymen, at a common meeting place, samples of their product, together with any inno-

vation in foundry equipment which they have to present. That an exhibition of this kind cannot be conducted without funds goes without saying. It is also necessary that these men who devote their time to making an exhibition possible and successful, should be compensated for their labor. It, however, does not mean that one individual or group of individuals should take advantage of the necessity of an exhibition and because of right of might, conduct an exhibition solely for the purpose of their own personal gain. Fundamentally the exhibition is for the mutual benefit of the exhibitors and foundrymen, and for no other purpose and for no other motive should an exhibition be conducted.

The A. F. A. has succeeded in raising the standard of its conventions, making each something other than a meeting place, and therefore, giving its exhibitor friends an opportunity to repay past favors. And so must any Exhibition Company and all affiliated associations enter into the same spirit and raise the standard in advocating that the basic principle for the existence of associations, and the purpose for the convention, is for the advancement of the foundry industry. Whether or not the exhibition should be conducted by the A. F. A., or the Exhibition Co., is still a question for debate. If the present organization is willing to meet the A. F. A. on an equal basis with the standard and purpose in mind, then personally, I should say that they should be permitted to continue. If not, then for the benefit of the A. F. A., and the A. I. M., and the exhibitors, it is high time that we secede and conduct the exhibition ourselves. In all this, we must not lose sight of the exhibitors, the people who make the exhibition possible. During the past few years the complaints they have registered because of exorbitant floor space rental and exorbitant service charges, have been many. The result has been that each year some of the exhibitors have dropped out, others have reduced the size of their exhibits, and some have reserved only desk room.

Realizing your sincerity of purpose in managing the affairs so as to bring about a harmonious understanding for the mutual benefit of all, I ask you to cast my vote for me.

Trusting that the results of this meeting in Cleveland will be satisfactory to all, and with kindest personal regards, I beg to remain,

Most sincerely yours,

W. A. Janssen,

Vice President.

Wheeling, W. Va., Nov. 22, 1915.

R. A. Bull, President,
American Foundrymen's Association,
Granite City, Ill.

Dear Mr. Bull:—

I have your letter of the 19th inst., in reply to the letter forwarded you by Mr. Backert. The reason I wrote Mr. Backert as I did was that from information I had been furnished I understood that the committee had been appointed to choose a place for the coming convention of the A. F. A., and not to determine the future relations between the Association and the Exhibition Co. I do not, in any way, doubt the responsibility which the individual members of the Committee were willing to assume in regard to the situation, but simply wanted to know whether the

Committee which had been appointed to do certain acts had the authority to extend these acts. I am not questioning, at all, the advisability of doing what the Committee has decided to do, and I am simply wondering where the responsibility of the balance of the Board would come in, providing anything should happen that this action should not meet the approval of the balance of the Association. Certainly wish to thank you for the information which you conveyed.

On the second page of your letter, you state that you realized that the Association put the matter of future co-operation between the A. F. A., and the Exhibition Co., in the hands of our Board and that the Board, in turn, placed it in the hands of our Committee of five, with power to act. As far as I know there has been no regularly called meeting of the Board this year, but if the Board did place this whole matter in the hands of the Committee with power to act and the Board has had a regular meeting for this purpose, then the whole request for information was useless. Do think, however, that if the Board has had a meeting and this action has been taken, at least those of the Board who were not notified of the meeting should at least be notified of the action which had been taken.

Yours very truly,

H. E. Field.

Granite City, Ill., Nov. 24, 1915.

Dear Mr. Field:—

I have your letter of Nov. 22, explaining why you wrote to Mr. Backert the letter that was forwarded to me from his office, and to which I replied. I note you do not seem to fully understand that the committee was properly empowered to the action it did, and that your speculations along this line do not necessarily arise from any belief on your part that the committee has acted unwisely.

Permit me to recall that we had a Board meeting at the Northfield Country Club, near Atlantic City, on Monday evening, Sept. 27, 1915, of which due notice was given each member of the Board by our Secretary; and that following my rather extended verbal explanation of negotiations I had been conducting with the Exhibition Co., through President Perkins and Secretary Hoyt, Henry A. Carpenter presented a motion, which was carried without dissent, empowering the writer to appoint a committee of five, of which, it was stipulated, Mr. Backert and I should be members, to continue negotiations with the Exhibition Co., and to have full power to act with reference to future co-operation with the Exhibition Co.

Subsequently, on the evening of Sept. 29, in the banquet room of the Hotel Traymore, Atlantic City, when we held our regular business meeting and election of officers, Mr. Howell presented a motion, which was carried unanimously, formally conferring upon the Executive Board authority to pass upon all matters touched upon in my so-called presidential address. In that address I said, "I recommend that you authorize your Board to make such arrangements covering future co-operation with that representing the Exhibition Co., as may seem advisable." Of course you will understand that I am quoting verbiage of the motions to the best of my ability, and from my recollection. Mr. Backert, as secretary, no doubt made careful notes, and his minutes have not been

issued. If I may judge from actions taken by Mr. Howell himself, who was appointed as a member of our committee of five, and from verbal expressions by Mr. Carpenter to Mr. Backert last week in New York during the annual meeting of the National Founders' Association, the sense of the motions conferring authority has been correctly interpreted by me. It will be seen that the Association has empowered the Board—which already had the authority by the phraseology of the constitution—and that the Board itself formally placed the matter in the hands of the committee of five.

I think the matter of authority will be made plain to you by this letter, particularly as you should recall the action taken at the Board meeting, having been present there yourself.

I do not quite understand your statement that you have no knowledge of any regularly called meeting of the Board this year. Of course, the meeting at the Northfield Country Club was held during the present calendar and fiscal year. Perhaps you may have reference to any meeting since the election of officers. There has been one such, which was held as per custom immediately following the final sessions, at which no matters of great importance were discussed. No regular call was sent out for that meeting, and in this, precedent was followed, as it has long been the custom to have such a meeting—if a quorum were present, and the Board members could remain for a few minutes following the adjournment. Precedent was again followed, by a motion adopted at this Board meeting which followed adjournment of the convention, that the time and place for the 1916 convention be decided by the president, senior vice president and secretary. In view of later developments concerning the attitude of the Exhibition Co., these three elected to have Messrs. Speer and Howell co-operate in the decision and thus make the committee of five responsible for all features of the situation.

As to your belief that those of the Board who were not notified of the meeting should at least have been advised of the action taken, I beg to emphasize that Mr. Backert notified all members of the Board of the proposed meeting at the Northfield Club, and that I wrote each member of the Board, including yourself, on Aug. 25, specially requesting attendance at that meeting, and mentioned my interviews with Messrs. Perkins and Hoyt concerning co-operation; also that each member of the Board received a copy of my letter of Nov. 9, in which I endeavored to explain the situation at length.

Yours very truly,

R. A. Bull.

Meeting of the Executive Board of the American Foundrymen's Association; Hotel Statler, Cleveland, Jan. 15, 1916.

Second Session

The second session of the meeting of the Executive Board of the American Foundrymen's Association, held at the Hotel Statler, Cleveland, Jan. 15, 1916, was called to order at 12:40 p. m., with President R. A. Bull in the chair.

The suggestions made by the secretary of the American Foundrymen's Association, for the conduct of the affairs of the American Foundrymen's Association with the added exhibition feature; the organization of an Exhibition Committee, etc., contained in a letter sent to all the members of the Executive Board by the president, R. A. Bull, were discussed at length, but no definite action was taken at this meeting which was adjourned at 1:00 p. m.

R. A. Bull, President.

A. O. Backert, Secretary.

Meeting of the Executive Board of the American Foundrymen's Association; Hotel Statler, Cleveland, Jan. 15, 1916.

Third Session

The third session of the meeting of the Executive Board of the American Foundrymen's Association, held at the Hotel Statler, Cleveland, Saturday, Jan. 15, 1916, was called to order at 2:30 p. m., with President R. A. Bull in the chair.

The meeting opened with a further discussion of the conduct of the affairs of the Association; the organization of an Exhibition Committee, and other suggestions made by the secretary.

Motion was made by B. D. Fuller and seconded by H. B. Swan, "that the conduct of the exhibition of foundry supplies and equipment exclusive of the disbursement of the net proceeds, be in the hands of a committee of eight, five representing the American Foundrymen's Association and three representing the exhibitors. The committee of five representing the American Foundrymen's Association shall consist of the president, senior vice president and the secretary-treasurer and two other members to be appointed by the Executive Board of the American Foundrymen's Association. The three representatives of the exhibitors also shall be appointed by the Executive Board of the American Foundrymen's Association. The members constituting this committee shall have power to vote in person or by proxy, at meetings to be called by the president of the American Foundrymen's Association." This motion was carried without dissent.

The chairman, R. A. Bull, then called for nominations for the two members of this committee of eight to be elected by the Executive Board of the American Foundrymen's Association, and Major Jos. T. Speer and Alfred E. Howell, having been duly nominated, were elected unanimously.

The chairman, R. A. Bull, then called for nominations for the three representatives of the exhibitors to serve as members of this committee of eight. S. T. Johnston, of the S. Obermayer Co.,

Chicago; V. E. Minich, of the Sand Mixing Machine Co., New York, and Franklin G. Smith, of the Osborn Mfg. Co., Cleveland, having been duly nominated, were unanimously elected.

The chairman of the meeting, R. A. Bull, was instructed to advise Messrs. Johnston, Minich and Smith of their election as members of this Committee of Eight.

Motion was made by Major Jos. T. Speer and seconded by H. B. Swan that the members of the Exhibition Committee of eight, with the exception of the secretary of the American Foundrymen's Association, be allowed a per diem of $15 and expenses, when in attendance at meetings of this committee, from the time of leaving home until they return. This motion was carried without dissent.

A motion was made by A. E. Howell and seconded by Major Jos. T. Speer, that it is the purpose and policy of the American Foundrymen's Association to make an equitable distribution between the American Foundrymen's Association and the American Institute of Metals on one part, and the exhibitors on the other part, of the net proceeds of the exhibition feature. This distribution is to be made by the Executive Board of the American Foundrymen's Association within a reasonable period after the close of the exhibition. This motion was carried without dissent.

Motion was made by A. E. Howell and seconded by Major Jos. T. Speer, that the secretary be instructed to make use of bound volumes of the *Transactions,* dating back several years and carried in stock by the American Foundrymen's Association in a campaign for new members. This motion was carried without dissent.

There being no further business, the meeting was adjourned.

R. A. Bull, President.

A. O. Backert, Secretary.

Minutes of the Meetings of the Special Committee of Five

MEETING OF THE SPECIAL COMMITTEE OF FIVE OF THE AMERICAN FOUNDRYMEN'S ASSOCIATION; HOLLENDEN HOTEL, CLEVELAND, OCT. 23, 1915.

The meeting of the Special Committee, appointed at the annual meeting of the Executive Board of the American Foundrymen's Association, to conduct negotiations with the Foundry & Machine Exhibition Co., held at the Hollenden Hotel, Cleveland, Oct. 23, 1915, was attended by the following:

R. A. Bull, Chairman, Commonwealth Steel Co., Granite City, Ill.
Major Jos. T. Speer, Pittsburgh Valve Foundry & Construction Co., Pittsburgh.
Alfred E. Howell, Phillips & Buttorff Mfg. Co., Nashville, Tenn.
J. P. Pero, Missouri Malleable Iron Co., East St. Louis, Ill.
A. O. Backert, secretary-treasurer, Cleveland.

President R. A. Bull presented a letter received from Jesse L. Jones, president of the American Institute of Metals, in which he authorized the special committee of five, appointed by the Executive Board of the American Foundrymen's Association with full power to act in behalf of the American Institute of Metals.

R. A. Bull, president of the American Foundrymen's Association and chairman of this special committee, read the correspondence which he had had with F. N. Perkins, president of the Foundry & Machine Exhibition Co., bearing upon the selection of a time and place for the 1916 meeting of the American Foundrymen's Association, the American Institute of Metals and the exhibition of the Foundry & Machine Exhibition Co., and also bearing upon the proposed agreement between the American Foundrymen's Association and the Foundry & Machine Exhibition Co.

After considerable discussion the following resolution, which was duly seconded, was adopted:

> *Whereas,* A continuation of the friendly relations existing between the American Foundrymen's Association and the American Institute of Metals, to be known hereafter as party of the first part, and the Foundry & Machine Exhibition Co., to be known hereafter as party of the second part, were sought to be continued on a basis agreeable to all parties concerned, and
>
> *Whereas,* Efforts were made to continue these friendly relations in concrete form, through an agree-

ment submitted by the party of the first part to the party of the second part, through its president, F. N. Perkins, Aug. 11, 1915, and subsequently a revised agreement similarly was submitted Aug. 23, 1915, on which no action was taken up to Oct. 23, 1915, and

Whereas, At a meeting of the undersigned special committee, appointed by the Executive Board of the American Foundrymen's Association, and empowered to act for the American Institute of Metals, by authority of the president of this organization, Jesse L. Jones, held at the Hollenden Hotel, Cleveland, Oct. 23, 1915, called for the purpose of considering this matter, and

Whereas, The Foundry & Machine Exhibition Co., the party of the second part, has failed to act on either of these proposed agreements, and

Whereas, It is essential to decide upon the time and place of the 1916 convention of the party of the first part at an early date, and since it is necessary to make immediate arrangements for the 1916 exhibition of foundry equipment, supplies, etc., to be held concurrently with the annual meetings of the party of the first part, therefore

Be it resolved, That sealed proposals be invited from corporations and individuals, capable of conducting exhibitions in a manner satisfactory to the undersigned special committee, which sealed proposals are to be delivered in the hands of the secretary-treasurer of the American Foundrymen's Association, A. O. Backert, 12th and Chestnut Streets, Cleveland, Ohio, on or before twelve o'clock noon, Eastern time, Saturday, Nov. 13, 1915; each proposal submitted must be accompanied by a certified check in the sum of Three Thousand ($3,000) Dollars to insure the faithful performance of the contract. The undersigned special committee reserves the right to accept or reject any or all proposals.

R. A. Bull, chairman.
J. P. Pero
Jos. T. Speer
Alfred E. Howell
A. O. Backert, secretary.
Special Committee.

The chairman of this special committee, R. A. Bull, was instructed to send a copy of this resolution to F. N. Perkins, president, and to C. E. Hoyt, secretary, of the Foundry & Machine Exhibition Co.

T. P. Cagwin, secretary of the Convention Board of the Cleveland Chamber of Commerce, attended this meeting and was invited to present a proposition to the American Foundrymen's Association for holding its exhibition in Cleveland.

After Mr. Cagwin's withdrawal, a motion was made and duly seconded to hold the annual meeting of the American Foundrymen's Association and the American Institute of Metals, and the exhibition to be conducted under the joint auspices of these two organizations, at Cleveland during the week of Sept. 11, 1916, conditional on satisfactory confirmation of Mr. Cagwin's verbal proposal.

There being no further business, the meeting adjourned.

R. A. Bull, Chairman.

A. O. Backert, Secretary.
Special Committee of Five.

Meeting of the Special Committee of Five of the American Foundrymen's Association; Fort Pitt Hotel, Pittsburgh, Nov. 7, 1915.

A meeting of the Special Committee of five of the American Foundrymen's Association and the American Institute of Metals was held at the Fort Pitt Hotel, Pittsburgh, Nov. 7, 1915, but immediately adjourned to the Anderson Hotel.

The following were in attendance:

R. A. Bull, chairman; Major Jos. T. Speer, Alfred E. Howell, J. P. Pero and A. O. Backert.

After a careful consideration of the proposed agreement presented by the Exhibition Co., it was unanimously declined.

R. A. Bull, president of the American Foundrymen's Association, was then instructed to notify F. N. Perkins, president, and C. E. Hoyt, secretary, of the Exhibition Co., of the action taken.

On motion by Alfred E. Howell, which was duly seconded, it was decided that in the future, the foundry exhibition conducted concurrently with the meetings of the American Foundrymen's Association and the American Institute of Metals, should be under the control and supervision of these two organizations. The sentiment was expressed at this meeting that the exhibition should be conducted on a basis that will be equally profitable to the American Foundrymen's Association, the American Institute of Metals and the exhibitors.

The secretary was instructed to send out a letter, copy of which is herewith attached, to all exhibitors and to the members of the American Foundrymen's Association. and it was suggested that he communicate with W. M. Corse, secretary of the American Institute

of Metals, with a view of having him send out a similar letter to all members of his organization.

After this action was taken, the meeting was adjourned to the home of J. S. Seaman, which was attended by Jesse L. Jones, president of the American Institute of Metals. Both Mr. Seaman and Mr. Jones heartily approved of the action that had been taken.

There being no further business, the meeting adjourned.

R. A. BULL, Chairman.

A. O. BACKERT, Secretary.

LETTER SENT TO THE MEMBERS OF THE AMERICAN FOUNDRYMEN'S ASSOCIATION.

Cleveland, Ohio, Nov. 8, 1915.

To the Members of the American Foundrymen's Association:

As a result of several conferences, held recently at Cleveland and Pittsburgh, respectively, by the special committee empowered by the American Foundrymen's Association and the American Institute of Metals, to select the time and place for the 1916 foundrymen's convention, it has been decided to meet in Cleveland, during the week of Sept. 11.

At Atlantic City the Executive Board of the American Foundrymen's Association authorized the appointment of a committee of five to decide upon next year's meeting place and this committee was instructed by the American Institute of Metals to serve also in its behalf. This Special Committee is constituted as follows: R. A. Bull, Commonwealth Steel Co., Granite City, Ill., president of the American Foundrymen's Association, chairman; Jos. T. Speer, Pittsburgh Valve Foundry & Construction Co., Pittsburgh, and Alfred E. Howell, Phillips & Buttorff Mfg. Co., Nashville, Tenn., past presidents; J. P. Pero, Missouri Malleable Iron Co., East St. Louis, Ill., senior vice president, and A. O. Backert, Cleveland, secretary-treasurer, American Foundrymen's Association.

The annual exhibition of foundry equipment and supplies, to be held concurrently with the meetings of these organizations, will be conducted under the auspices of the American Foundrymen's Association and the American Institute of Metals. This decision was reached after mature deliberation and represents the unanimous action of the members of this Special Committee. It also has been approved heartily by J. S. Seaman, Seaman-Sleeth Co., Pittsburgh, past president of the American Foundrymen's Association, and Jesse L. Jones, Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa., president of the American Institute of Metals, with whom the members of the special committee met for counsel and advice.

Since the interests of manufacturers of foundry equipment and supplies, who make exhibits at these annual shows, and the members of the American Foundrymen's Association and the American Institute of Metals are mutual, it is the sentiment of this Special Committee that the exhibitors should share in the profits to be paid in the form of rebates on the cost of their space.

The exhibition will be held in the Cleveland Coliseum, located on Thirteenth street in the center of Cleveland's business district. The Coliseum is within one block of the Hotel Statler, three blocks from the Hollenden and is only a short walking distance from the other Cleveland hotels. It contains 60,000 square feet of floor space on one level and is admirably adapted for a foundry show.

Sealed proposals have been invited from corporations and individuals capable of conducting exhibits, which are to be submitted to the secretary of this special committee, A. O. Backert, Twelfth and Chestnut streets, Cleveland, O., on or before 12 o'clock noon, Eastern time, Saturday, Nov. 13, 1915.

This communication has been authorized by this special committee and its secretary has been instructed to notify you of the action taken.

Sincerely yours,

A. O. BACKERT,
Secretary Special Committee.
American Foundrymen's Association.
American Institute of Metals.

MEETING OF THE SPECIAL COMMITTEE OF THE AMERICAN FOUNDRYMEN'S ASSOCIATION; HOTEL ANDERSON, PITTSBURGH, DEC. 19, 1915.

A meeting of the Special Committee, representing the American Foundrymen's Association and the American Institute of Metals, was held at the Hotel Anderson, Pittsburgh, Dec. 19, 1915.

All members were in attendance as follows: R. A. Bull, chairman; Major Jos. T. Speer, Alfred E. Howell, J. P. Pero and A. O. Backert. Jesse L. Jones, president of the American Institute of Metals, also was present.

A committee representing the Foundry & Machine Exhibition Co., consisting of George R. Rayner, of the Carborundum Co., Niagara Falls, N. Y., and L. L. Munn, of the Arcade Mfg. Co., Freeport, Ill., sought information regarding the cause of the action taken by our joint societies in deciding to conduct the exhibition at Cleveland in 1916. After considerable discussion, it was decided, unanimously, by those representing the American Foundrymen's Association and the American Institute of Metals, that the Exhibition Co. could not afford to make any proposition that might be considered satisfactory, and under these conditions it seemed best to proceed with plans for holding the exhibition under our control next year.

Major Jos. T. Speer offered a motion, which was seconded and carried, to empower, subject to the approval of the Executive Board, President R. A. Bull, senior Vice President J. P. Pero and Secretary-Treasurer A. O. Backert to engage a manager for the

1916 show without restriction as to when he can be engaged or what his compensation shall be. It was the sense of all present that such a manager should, if possible, be engaged by the month, so that in the event of his services not being satisfactory, a change could be made.

President R. A. Bull stated that since the Special Committee had now performed the duties delegated to it by the Executive Board, he would ascertain the wishes of the Board as to further action.

It was the sense of the Special Committee that the customary exhibitor's license of $25.00 should be required for the 1916 exhibition, and that the former price for floor space, namely, that of 50 cents per square foot, except corner space, which should be 60 cents per square foot, should be maintained; that each person holding a card of membership in either the American Foundrymen's Association or the American Institute of Metals, should have free entrance to the exhibition, at all times; and that every exhibitor should be furnished, gratis, one exhibitor's button, entitling the wearer to enter without expense. It was thought advisable to make all others pay an admission fee of 25 cents, or $1.00 for a season ticket, and that all exhibitors should be notified that a rebate will be made proportionate to the space occupied, after the close of the convention and the proper needs of the American Foundrymen's Association and the American Institute of Metals were cared for.

It was also thought advisable to ask for expressions of opinions from exhibitors as to the days on which the exhibition should be kept open and they shall be given to understand that suggestions from them will be welcome at all times.

There being no further business, the meeting adjourned.

R. A. Bull, Chairman.

A. O. Backert, Secretary.

Minutes of the Meetings of the Exhibition Committee

MEETING OF THE EXHIBITION COMMITTEE OF THE AMERICAN FOUNDRYMEN'S ASSOCIATION; FORT PITT HOTEL, PITTSBURGH, FEB. 27, 1916.

The first meeting of the Exhibition Committee of the American Foundrymen's Association, under whose auspices the exhibition of foundry supplies and equipment will be held at the Cleveland Coliseum, Cleveland, concurrent with the annual meetings of the American Foundrymen's Association and the American Institute of Metals, during the week of Sept. 11, was held at the Fort Pitt Hotel, Pittsburgh, Feb. 27, 1916.

Every member of the committee was in attendance, as follows:

R. A. Bull, president of the American Foundrymen's Association, chairman, Commonwealth Steel Co., Granite City, Ill.

Major Jos. T. Speer, Pittsburgh Valve Foundry & Construction Co., Pittsburgh.

Alfred E. Howell, Phillips & Buttorff Mfg. Co., Nashville, Tenn.

J. P. Pero, Missouri Malleable Iron Co., East St. Louis, Ill.

A. O. Backert, secretary-treasurer of the American Foundrymen's Association, Cleveland.

S. T. Johnston, S. Obermayer Co., Chicago.

V. E. Minich, Sand Mixing Machine Co., New York.

W. A. Janssen, Bettendorf Co., Davenport, Ia., one of the vice presidents of the American Foundrymen's Association, also was in attendance, as well as C. E. Hoyt, formerly secretary of the Exhibition Co.

The morning session was called to order at 10:30 a. m., with R. A. Bull in the chair.

C. E. Hoyt was requested to make a proposition for the conduct of the Cleveland exhibition. He offered to conduct the Cleveland exhibition on the basis of remuneration to him of 20 cents per square foot for the first 20,000 square feet sold and 10 cents per square foot on all space sold over 20,000 square feet. This remuneration is to include Mr. Hoyt's services in the conduct of the exhibition, the conduct of his office at Chicago, including stenographic service, clerical help, office rent, local telephone, office equipment and supplies, traveling expenses incurred in obtaining exhibits and in attending meetings of the Exhibition Committee, as well as expenses incurred in traveling to and from the point at which the exhibition is to be held, prior to the time of installation and

conduct of the exhibition. The expenses to be borne by the exhibition fund, include stationery, printing, postage, advertising, expenses at the exhibition prior to, during and after the show for Mr. Hoyt and his three or four assistants, the installation and cost of power, railings, decorations, installation of exhibits, janitor service and help for registration, and all expenses directly traceable to the exhibition feature. After explaining these provisions, Mr. Hoyt asked to be excused to permit the committee to discuss his proposition in detail.

Motion was made by Major Jos. T. Speer and seconded by V. E. Minich that the president be authorized to enter into a contract with C. E. Hoyt to conduct the 1916 exhibition of foundry supplies and equipment, in the capacity of exhibition manager of the American Foundrymen's Association on the following basis: Mr. Hoyt is to receive 20 cents per square foot on the first 20,000 square feet of space sold, and 10 cents per square foot on all space sold in excess of 20,000 square feet. This motion was carried without dissent.

The question of handling the exhibition funds was discussed at length and it was decided to have an exhibition account entirely separate from the regular account of the American Foundrymen's Association for the conduct of the Cleveland exhibition. Motion was made by J. P. Pero and seconded by Major Jos. T. Speer that the receipt and disbursement of the exhibition funds and the method of carrying this account be left to the president and secretary-treasurer of the American Foundrymen's Association, with power to act. This motion was carried without dissent.

The question of appointing another member of the Exhibition Committee to represent the exhibitors then was discussed and it was suggested that the secretary be instructed to communicate with H. S. Covey, secretary, the Cleveland Pneumatic Tool Co., Cleveland, with authority to extend to him such appointment, providing he would consider it favorably. Mr. Covey was seen by the secretary at Cleveland, Feb. 29, and Mr. Covey signified his willingness to serve in such capacity. The president, R. A. Bull, was immediately communicated with and he made the appointment official.

Motion was made by Major Jos. T. Speer and seconded by J. P. Pero, that the secretary, A. O. Backert, be instructed to take steps to obtain insurance for the protection of the public and employes at the Cleveland exhibition. This motion was carried without dissent.

The secretary was then instructed to make an announcement to the members and trade papers of the action taken at this meeting.

Motion was made by Alfred E. Howell and seconded by V. E. Minich that an exhibition fee of $25.00 be charged all

exhibitors this year and that floor space be sold at the rate of 50 cents per square foot for ordinary space and 60 cents per square foot for corner space. This motion was carried without dissent.

There being no further business, the meeting adjourned.

R. A. Bull, Chairman.

A. O. Backert, Secretary.

Meeting of the Exhibition Committee of the American Foundrymen's Association; Hotel Statler, Cleveland, June 24, 1916.

The second meeting of the Exhibition Committee of the American Foundrymen's Association was held at the Hotel Statler, Cleveland, June 24, 1916.

R. A. Bull, president of the American Foundrymen's Association and chairman of this committee, was unable to attend and Senior Vice President J. P. Pero therefore presided.

The following members of this committee were present: J. P. Pero; Major Jos. T. Speer; Alfred E. Howell; S. T. Johnston, V. E. Minich; H. S. Covey and A. O. Backert. B. D. Fuller, one of the vice presidents of the American Foundrymen's Association, also was in attendance, as well as C. E. Hoyt, exhibition manager for the American Foundrymen's Association.

At the meeting held Sunday, Feb. 27, motion was made by Major Jos. T. Speer, and seconded by J. P. Pero, that the secretary be instructed to take steps to obtain insurance for the protection of the public and the employes at the Cleveland exhibition. Upon motion by Alfred E. Howell, seconded by Major Jos. T. Speer, this action was unanimously rescinded.

Alfred E. Howell then offered a resolution which was seconded by S. T. Johnston, instructing C. E. Hoyt, exhibition manager, to obtain liability, fire and other insurance for the full protection of the exhibition feature. This resolution was carried without dissent.

The contract with C. E. Hoyt, which the Exhibition Committee authorized President R. A. Bull and Secretary A. O. Backert to enter into, was then read and approved, but C. E. Hoyt reported that he had not yet furnished the $5,000 bond provided for. He then was instructed to obtain this bond in the immediate future.

C. E. Hoyt presented a statement outlining the progress that is being made in obtaining exhibitors, and he reported that a total of 95 manufacturers already had reserved space totaling an approximate floor area of 28,000 square feet. He was of the opinion that the exhibition space in the Coliseum would prove inadequate for the requirements of these exhibitors and he recommended the erec-

tion of a temporary building on a lot directly across the street from the Coliseum. The plan is to erect a tent, boarded on the inside to a height of six feet, the walls of the tent to be 10 feet high and the intervening space to be covered with canvas. He also presented an estimate of the cost of erecting of this temporary building, with flooring, etc.

It was moved by Alfred E. Howell and seconded by H. S. Covey that the erection of a temporary building, as outlined by Mr. Hoyt, be authorized and that the awarding of the contract and other details in connection with the erection of this building be placed in the hands of a sub-committee of three. This motion was adopted without dissent.

Chairman J. P. Pero then appointed H. S. Covey, C. E. Hoyt and A. O. Backert members of this committee.

The question of concessions was next discussed and it was the concensus of opinion that a booth should be provided, either in the Coliseum or in the temporary building, for the sale of soft drinks, sandwiches, etc., and upon motion by Alfred E. Howell, seconded by S. T. Johnston, the question of concessions was left in the hands of the sub-committee, consisting of H. S. Covey, C. E. Hoyt and A. O. Backert. This motion was adopted unanimously.

The question of free admission to the exhibition was then discussed and upon motion by S. T. Johnston, seconded by Alfred E. Howell, the following resolution was adopted unanimously:

> Resolved, That members of the American Foundrymen's Association and the American Institute of Metals, in good standing, will be admitted to the exhibition upon presentation of their membership cards for the year 1916-1917, indicating that their dues are paid to July 1, 1917. Each member is entitled to one membership card only, and therefore, access to the exhibition can be had only by the bearer of this card.

A motion was made by H. S. Covey and seconded by Major Jos. T. Speer, which provides for issuing one exhibition permit to each exhibitor, admitting him to the exhibition. This exhibition permit can be carried by only one member of the concern making the exhibit, all other representatives of the exhibitors being compelled to pay $1.00 for a season ticket, or 25 cents for a single admission. This motion was adopted unanimously.

Motion was made by Alfred E. Howell and seconded by S. T. Johnston, that laborers in the employ of exhibitors be supplied with season tickets at a price of $1.00, this sum to be refunded to the exhibitors upon the surrender of the ticket. This motion was carried unanimously.

It was the concensus of opinion that an extensive publicity campaign should be conducted, and after considerable discussion

an appropriation of $3,500 was made to cover all necessary publicity expenses. This motion, which was presented by Major Jos. T. Speer, seconded by Alfred E. Howell and unanimously carried, also provided that the expenditure of this fund be left in the hands of the sub-committee of three, consisting of H. S. Covey, C. E. Hoyt and A. O. Backert. A large poster, 8,000 of which will be printed, was displayed and further details of the publicity campaign were discussed.

The exhibition registration problem was considered at length, and it was decided unanimously, upon motion by S. T. Johnston, seconded by V. E. Minich, that the registration in the exhibition hall be conducted as heretofore.

At the previous meeting of the Exhibition Committee, held at Pittsburgh, Feb. 27, it was decided to continue the exhibition for a period of five days, namely, Monday, Sept. 11; Tuesday, Sept. 12; Wednesday Sept. 13; Thursday, Sept. 14 and Friday, Sept. 15. A number of exhibitors have requested that the exhibition be conducted an additional day and C. E. Hoyt urged that the exhibition remain open on Saturday, Sept. 16, making a total of six days in place of five days as heretofore decided.

A motion was made by S. T. Johnston and seconded by Alfred E. Howell, to the effect that the exhibition close on Saturday, Sept. 16, at 5:00 p. m., the opening hour and day remaining the same as heretofore. This motion was adopted unanimously.

C. E. Hoyt suggested that a guessing contest be conducted at the exhibition and he was of the opinion that by offering cash prizes, considerable interest would be aroused in this feature. It was his opinion that perhaps a large, intricate casting could be obtained, the weight of which would be unknown and prizes would be offered for those who would guess nearest its weight. Upon motion by Alfred E. Howell, which was seconded by V. E. Minich, an appropriation of $100 was made for this feature, to be charged to the publicity appropriation, the details of the contest to be left in the hands of the sub-committee of three, consisting of H. S. Covey, C. E. Hoyt and A. O. Backert. This motion was adopted without dissent.

Adjournment was taken at noon for luncheon, which was attended by the chairmen of the various local committees appointed by the president, R. A. Bull. Following the luncheon, a meeting of these chairmen was held in conjunction with the members of the exhibition committee and plans for the reception and entertainment of the visiting foundrymen were discussed in detail. Considerable enthusiasm was manifested and it was decided to hold another meeting of these chairmen on Friday, June 20, at the Hotel Statler. Each chairman was instructed to make his own committee appointments.

The chairmen of these various local committees, follow:

Local General Committee, F. B. Whitlock, Interstate Foundry Co.

Plant Visitation Committee, J. S. Smith, Smith Facing & Supply Co.

Entertainment Committee, Sterling Hubbard, Rogers, Brown & Co.

General Reception Committee, Herbert Boggis, Taylor & Boggis Foundry Co.

Vice Chairman, General Reception Committee, Philip Frankel, Cleveland Foundrymen's Association.

Golf Committee, W. B. Greene, Palmer & De Mooy Foundry Co.

Finance Committee, J. C. Brainard, Johnston & Jennings Co.

Ladies' Entertainment Committee, Mrs. W. C. Sly, 13474 Lake Avenue.

J. C. Brainard was the only absentee, Mrs. W. C. Sly not having been invited to attend this meeting.

After the adjournment of this meeting of the chairmen of the local committees, the Exhibition Committee again went into session and continued deliberations until 3:30 p. m.

J. P. Pero, Chairman.

A. O. Backert, Secretary.

Minutes of Meetings to Effect the Incorporation of the American Foundrymen's Association

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MEETING OF FOUNDRYMEN OF THE UNITED STATES AND CANADA, HELD AT THE HOTEL STATLER, CLEVELAND, SATURDAY, JAN. 15, 1916, FOR THE PURPOSE OF ORGANIZING THE AMERICAN FOUNDRYMEN'S ASSOCIATION, INCORPORATED.

A meeting of foundrymen of the United States and Canada was held at the Hotel Statler, Cleveland, Jan. 15, 1916, for the purpose of organizing the American Foundrymen's Association, incorporated.

The following were in attendance:

R. A. Bull, Commonwealth Steel Co., Granite City, Ill.
Major Jos. T. Speer, Pittsburgh Valve Foundry & Construction Co., Pittsburgh.
Alfred E. Howell, Phillips & Buttorff Mfg. Co., Nashville, Tenn.
J. P. Pero, Missouri Malleable Iron Co., East St. Louis, Ill.
S. B. Chadsey, Massey-Harris Co., Ltd., Toronto, Canada.
B. D. Fuller, Westinghouse Electric & Mfg. Co., Cleveland.
H. B. Swan, Cadillac Motor Car Co., Detroit.
A. O. Backert, Cleveland.

R. A. Bull, Commonwealth Steel Co., Granite City, Ill., was elected temporary chairman, and A. O. Backert, Cleveland, temporary secretary.

Motion was made by Major Jos. T. Speer and seconded by J. P. Pero that all of the members of the Executive Board of the American Foundrymen's Association should be extended an invitation to become incorporators of the American Foundrymen's Association, incorporated. The motion was carried without dissent.

It was moved by B. D. Fuller and seconded by J. P. Pero, that a committee of three be appointed by the acting chairman to nominate officers for the proposed organization to be known as the American Foundrymen's Association, incorporated, this committee being instructed to report after expressions of opinion are received from members of the Executive Board of the American Foundrymen's Association. This motion was carried without dissent. Temporary Chairman R. A. Bull appointed B. D. Fuller, Westinghouse Electric & Mfg. Co., Cleveland, chairman of this com-

mittee, and the other members are A. E. Howell, Phillips & Buttorff Mfg. Co., Nashville, Tenn., and H. B. Swan, Cadillac Motor Car Co., Detroit.

H. B. Swan presented a motion, seconded by J. P. Pero, that the American Foundrymen's Association, incorporated, should incorporate under the laws of the State of Ohio. This motion was passed without dissent.

It was moved by A. E. Howell, and duly seconded, that the temporary chairman, R. A. Bull, and the temporary secretary, A. O. Backert constitute a committee to prepare a constitution and by-laws for the American Foundrymen's Association, incorporated, after having received legal advice. This motion was carried without dissent.

Motion was made by Major Jos. T. Speer and seconded by A. E. Howell that the meeting be declared adjourned, after which adjournment was taken.

R. A. Bull, Temporary Chairman.

A. O. Backert, Temporary Secretary.

Meeting Held at the Fort Pitt Hotel, Pittsburgh, Feb. 27, 1916, for Further Considering the Organizing of the American Foundrymen's Association, Incorporated

The second meeting of foundrymen of the United States and Canada to consider the organization of The American Foundrymen's Association, incorporated, was held at the Fort Pitt Hotel, Pittsburgh, Feb. 27, 1916.

The following were in attendance:

R. A. Bull, Commonwealth Steel Co., Granite City, Ill.
Major Jos. T. Speer, Pittsburgh Valve Foundry & Construction Co., Pittsburgh.
Alfred E. Howell, Phillips & Buttorff Mfg. Co., Nashville, Tenn.
J. P. Pero, Missouri Malleable Iron Co., East St. Louis, Ill.
A. O. Backert, Penton Publishing Co., Cleveland.
V. E. Minich, Sand Mixing Machine Co., New York.
S. T. Johnston, S. Obermayer Co., Chicago.
W. A. Janssen, Bettendorf Co., Davenport, Ia.
C. E. Hoyt, Lewis Institute, Chicago.

R. A. Bull was elected temporary chairman and A. O. Backert, temporary secretary.

The motion presented at the meeting held at the Hotel Statler, Jan. 15, 1916, made by H. B. Swan, and seconded by J. P. Pero, that the American Foundrymen's Association should incorporate under the laws of the state of Ohio, was presented for reconsideration and was rescinded unanimously.

A motion then was made by Alfred E. Howell and seconded by Major Jos. T. Speer that the American Foundrymen's Association, incorporated, be incorporated not for profit, in the state of Illinois or any other state whose laws are advantageous to such incorporation, decision as to the state to be left to the president. This motion was carried without dissent.

It was suggested that the representatives of the Exhibition Committee and C. E. Hoyt be included among the list of incorporators, in addition to those noted in attendance at the meeting held at the Hotel Statler, Cleveland, Jan. 15, 1916.

The report of the nominating committee was presented by Alfred E. Howell, in the absence of B. D. Fuller, chairman. R. A. Bull was nominated for president and A. O. Backert was nominated for the joint office of secretary-treasurer and C. E. Hoyt for manager of exhibits. The foregoing were unanimously elected.

There being no further business, the meeting adjourned.

R. A. Bull, President.

A. O. Backert, Secretary.

Meeting of the Board of Directors of the American Foundrymen's Association, Incorporated

The first meeting of the Board of Directors of the American Foundrymen's Association, incorporated, was held at the Hotel Statler, Cleveland, Aug. 6, 1916.

As provided in the charter granted the American Foundrymen's Association, incorporated, by the state of Illinois, July 3, 1916, the management of this corporation is vested in a board of 16 directors as follows:

R. A. Bull, Commonwealth Steel Co., Granite City, Ill.
C. E. Hoyt, Lewis Institute building, Chicago.
H. B. Swan, Cadillac Motor Car Co., Detroit.
B. D. Fuller, Westinghouse Electric & Mfg. Co., Cleveland.
A. H. Thomas, Buckeye Steel Castings Co., Columbus, O.
Walter Wood, R. D. Wood & Co., Philadelphia.
Alex. T. Drysdale, U. S. Cast Iron Pipe & Foundry Co., Burlington, N. J.
Alfred E. Howell, Phillips & Buttorff Mfg. Co., Nashville, Tenn.
J. P. Pero, Missouri Malleable Iron Co., East St. Louis, Ill.
S. T. Johnston, S. Obermayer Co., Chicago.
A. O. Backert, Penton Publishing Co., Cleveland.
H. S. Covey, Cleveland Pneumatic Tool Co., Cleveland.
Major Jos. T. Speer, Pittsburgh Valve Foundry & Construction Co., Pittsburgh.
V. E. Minich, Sand Mixing Machine Co., New York.
H. A. Carpenter, General Fire Extinguisher Co., Providence, R. I.
W. A. Janssen, Bettendorf Co., Davenport, Ia.

The following directors were in attendance:

R. A. Bull, Commonwealth Steel Co., Granite City, Ill.
A. O. Backert, Penton Publishing Co., Cleveland.
H. S. Covey, Cleveland Pneumatic Tool Co., Cleveland.
B. D. Fuller, Westinghouse Electric & Mfg. Co., Cleveland.
Alfred E. Howell, Phillips & Buttorff Mfg. Co., Nashville, Tenn.
C. E. Hoyt, Lewis Institute building, Chicago.
W. A. Janssen, Bettendorf Co., Davenport, Ia.
S. T. Johnston, S. Obermayer Co., Chicago.
V. E. Minich, Sand Mixing Machine Co., New York City.

J. P. Pero, Missouri Malleable Iron Co., East St. Louis, Ill.
Major Jos. T. Speer, Pittsburgh Valve Foundry & Construction Co., Pittsburgh.
H. B. Swan, Cadillac Motor Car Co., Detroit.

R. A. Bull, Commonwealth Steel Co., Granite City, Ill., was elected temporary chairman, and A. O. Backert, Penton Publishing Co., Cleveland, temporary secretary.

R. A. Bull announced that pursuant to a call issued by him, a meeting of the committee appointed for the purpose of drafting by-laws for the American Foundrymen's Association, incorporated, was held at the Hotel La Salle, Chicago, July 30, 1916. This committee was constituted as follows:

R. A. Bull, Commonwealth Steel Co., Granite City, Ill.
A. O. Backert, Penton Publishing Co., Cleveland.
C. E. Hoyt, Lewis Institute building, Chicago.
W. A. Janssen, Bettendorf Co., Davenport, Ia.
J. P. Pero, Missouri Malleable Iron Co., East St. Louis, Ill.

This meeting also was attended by E. J. Vaughn, Granite City, Ill., who served in the capacity of legal adviser.

A copy of the by-laws, as prepared by this committee, was presented to the Board of Directors for consideration. After much discussion it was moved by Jos. T. Speer and seconded by V. E. Minich, that the various articles of the By-Laws be adopted seriatum and this motion prevailed unanimously.

After the adoption of each article of the By-Laws, motion was made by Major Jos. T. Speer and seconded by J. P. Pero, that the By-Laws be adopted as read and this was passed without dissent. The By-Laws of the American Foundrymen's Association, incorporated, as adopted constitute a part of these minutes.

The chairman, R. A. Bull, then announced that the next order of business was the election of officers as prescribed by the By-Laws. Nominations were called for the office of president. R. A. Bull, Commonwealth Steel Co., Granite City, Ill., was nominated for president by J. P. Pero, which was seconded by C. E. Hoyt, and after the adoption of a motion to close the nomination, R. A. Bull was unanimously elected president of the American Foundrymen's Association, incorporated, the temporary secretary having cast the ballot for the directors.

J. P. Pero, Missouri Malleable Iron Co., East St. Louis, Ill., was nominated for the office of vice president by A. E. Howell, which was seconded by W. A. Janssen. A motion to close the nominations prevailed and J. P. Pero was unanimously elected vice president, the temporary secretary having cast the ballot for the directors.

A motion was made by A. E. Howell, which was seconded by C. E. Hoyt, that the office of secretary and treasurer be combined as provided in the By-Laws and this motion was passed without dissent.

A. E. Howell nominated A. O. Backert, Penton Publishing Co., Cleveland, for the office of secretary-treasurer of the American Foundrymen's Association, incorporated, which was seconded by W. A. Janssen, and after declaring the nominations closed, A. O. Backert was unanimously elected secretary-treasurer, the ballot having been cast by the president, R. A. Bull.

Motion was made by A. E. Howell, seconded by W. A. Janssen, that a salary of $1,800 per year, payable in twelve installments of $150 per month, be paid the secretary-treasurer and this motion was passed without dissent.

A motion was made by Major Jos. T. Speer, which was seconded by J. P. Pero, that C. E. Hoyt, Lewis Institute building, Chicago, be engaged in the capacity of exhibition manager of the American Foundrymen's Association, incorporated, under the same agreement and contract entered into on March 15, 1916, with the American Foundrymen's Association, not incorporated. This motion was adopted unanimously.

Motion was made by J. P. Pero, which was seconded by Alfred E. Howell, that the president be authorized to appoint an Exhibition Committee to be constituted of eight members of the Board of Directors. This motion prevailed without dissent, and President R. A. Bull announced the appointment of the following directors as members of the Exhibition Committee:

R. A. Bull, Commonwealth Steel Co., Granite City, Ill.
A. O. Backert, Penton Publishing Co., Cleveland.
H. S. Covey, Cleveland Pneumatic Tool Co., Cleveland.
A. E. Howell, Phillips & Buttorff Mfg. Co., Nashville, Tenn.
S. T. Johnston, S. Obermayer Co., Chicago.
V. E. Minich, Sand Mixing Machine Co., New York City.
J. P. Pero, Missouri Malleable Iron Co., East St. Louis, Ill.
Major Jos. T. Speer, Pittsburgh Valve Foundry & Construction Co., Pittsburgh.

The following resolution offered by Major Jos. T. Speer and seconded by S. T. Johnston, was then presented and unanimously adopted:

> Resolved, That a per diem of $15 be paid from the funds of the American Foundrymen's Association, incorporated, to all members of the Board of Directors and committees of this Board of Directors for all meetings which they attend, with the exception of meetings held at the time of the annual conventions. This per diem is to be paid from the time the Directors leave their homes until their return. In addition to this

per diem of $15 per day, all expenses of the members of the Board of Directors and committees of this Board, are to be paid from the funds of the American Foundrymen's Association, incorporated, incurred in attending meetings, except those held in connection with the annual conventions. No per diem is to be allowed any salaried officer of the American Foundrymen's Association, incorporated, or any officer or director employed by the Association on a commission basis. However, the expenses of such salaried officer or officers are to be paid for attendance at all meetings of the Board of Directors of the American Foundrymen's Association, Incorporated, and for expenses incurred in attendance at committee meetings of this Board, unless otherwise provided by contract or other written agreement with the American Foundrymen's Association, incorporated. The officers engaged on a commission basis shall be allowed their expenses incurred in attendance at meetings of the Board of Directors.

There being no further business, the meeting adjourned.

R. A. BULL, President.

A. O. BACKERT, Secretary.

By-laws of the American Foundrymen's Association

(Incorporated)

ARTICLE I

Name and Object

Section 1.—This incorporated association shall be known as the American Foundrymen's Association, incorporated, and it is, and shall be considered, a re-organization and continuation of the American Foundrymen's Association, not incorporated.

Section 2.—The object of this Association is to promote the arts and sciences practiced or applied by foundry operators, or others concerned in the production of castings; and to this end, to hold and conduct meetings of its members for the consideration and discussion of subjects pertaining or related to the business of foundry operators; to hold exhibits, displays and demonstrations of useful machinery, equipment and methods; to print, publish and distribute papers, discussions and other information pertaining to the business of foundrymen; and by other lawful means to promote the technical interests of the foundry industry and the welfare of all persons therein or connected therewith.

ARTICLE II

Membership

Section 1.—The membership of this Association shall consist of three classes, to be designated, respectively, Active, Associate and Honorary Members.

Section 2.—Any person engaged in the production of castings of any kind, as an employer, manager or superintendent, or as assistant to such, together with any others especially qualified, may be elected to Active Membership.

Section 3.—Any person who is engaged in foundry work, such as melting foreman, molding foreman, core foreman, pattern foreman, chipping foreman, chemist, etc., or any officer or employe of any firm or corporation, or any other person having an interest in foundry operations, though not engaged in the production of castings, may be elected to Associate Membership.

Section 4.—Any person whose knowledge of the foundry business or any branch thereof, or whose services in connection with the objects of this Association, make him pre-eminent among his fellows, may be elected to Honorary Membership.

Section 5.—Election to Active and Associate Membership shall be by the Board of Directors, and all applications for such membership shall be made in writing to the Secretary, by whom they shall be referred to the Directors.

Section 6.—Election to Honorary Membership shall be by a two-thirds vote of the Active and Honorary Members of the Association present at a regular meeting, voting upon a recommendation of the Board of Directors that such Honorary Membership be conferred.

Section 7.—Each Active member shall receive gratis the Transactions of the Association in bound volume form.

Section 8.—Associate members shall have all rights and privileges of Active members, except the right to vote, to hold office, and to receive gratis the Transactions of the Association in bound volume form; but Associate members shall receive gratis, pamphlet copies of all pre-printed, original papers read at conventions, and all other pamphlets which may be issued by the Association.

Section 9.—Honorary Members shall be entitled to all of the rights and privileges of Active Members, but they shall not be assessed for any dues or payments of any kind.

Section 10.—Members of the American Foundrymen's Association, un-incorporated, shall, without payment of any entrance fee, become members of this incorporated Association, in accordance with its by-laws, by indicating in writing their acceptance of membership herein. On such transfer of membership, the member shall be credited for dues in this Associa-

tion for the same time for which his dues are paid in said un-incorporated Association. All Honorary members of the American Foundrymen's Association, un-incorporated, shall be enrolled as Honorary members of the American Foundrymen's Association, incorporated.

ARTICLE III

Officers

Section 1.—The management of this Association shall be vested in a board of sixteen Directors who shall be elected annually, from and by the Active and Honorary members.

Section 2.—The other officers of this Association shall be a President, a Vice President, a Secretary and a Treasurer, each of whom shall be elected annually from and by the members of the Board of Directors, elected to serve for that year. The election of these officers shall be held immediately following the election of Directors. The offices of Secretary and Treasurer, in the discretion of the Board of Directors, may be combined.

ARTICLE IV

Meetings

Section 1.—There shall be an annual meeting of this Association, the date and location of which shall be fixed by the Board of Directors at least three months in advance of the meeting. Twenty-five members shall constitute a quorum of the Association.

Section 2.—Special meetings of the Board of Directors may be called at any time by the President, and shall be called by him on the written request of any three members of the said board. Not less than three days' notice in writing shall be given each Director, for any meeting. Five members of the Board shall constitute a quorum thereof. A regular meeting of said Board shall be held annually at 12 o'clock, noon, on the day prior to the first day of the annual meeting of the Association and at the place of said annual meeting.

ARTICLE V

Duties of Officers

Section 1.—The duties of the President shall be to preside at the meetings of the Association and of the Board of Directors and to perform such other duties as usually devolve upon the chief executive officer.

Section 2.—The Vice President shall perform the duties of the President when the latter is absent or unable to perform the same, and he shall become President in case of a vacancy in that office.

Section 3.—The duties of the Secretary shall be to keep a complete and accurate record of the proceedings of the Association and Board of Directors; to make a detailed report at the annual meeting concerning the membership of the Association; and to perform such other duties as may be assigned to him by the President or Board of Directors. He shall collect all moneys due the Association and shall transmit such funds to the Treasurer.

Section 4.—The Treasurer shall disburse the funds of the Association upon vouchers issued by the Secretary and approved by him and the President. Checks issued by the Treasurer for the disbursement of the funds of the Association must be countersigned by the President. The Treasurer shall give a bond, the amount of which shall be fixed by the Board of Directors, the premium on said bond to be paid by the Association.

Section 5.—An annual audit of the books and accounts of the Secretary and Treasurer shall be made by a certified public accountant to be named by the President, and said audit shall be submitted at the annual meeting.

Section 6.—The management and control of the affairs and property of the Association shall be vested in the Board of Directors. Said Board shall have authority to provide for the holding of exhibitions concurrently with the annual meetings of the Association, and shall have charge of the same.

ARTICLE VI

Salaries

Section 1.—The Board of Directors shall, in their discretion, annually authorize suitable compensation to be paid the Secretary and any other persons whose services to the Association justify such action. Complete information concerning all salaries or compensation paid shall be published annually in the Transactions.

ARTICLE VII

Dues

Section 1.—The entrance fee for Active members shall be $10.00, which must be submitted with the application. Dues for Active members shall be $10.00 per annum.

Section 2.—The entrance fee for Associate members shall be $5.00, which must be submitted with the application. Dues for Associate members shall be $5.00 per annum.

Section 3.—All dues shall be payable annually in advance on the first day of July, and any member whose dues are twelve months in arrears shall have his name automatically dropped from the membership rolls.

Section 4.—Within thirty days after notification of election, applicants for membership shall forward to the Secretary their annual dues, or their election will be invalidated and their entrance fees forfeited.

Section 5.—Entrance fees shall apply to continuous membership only, and those who allow their membership to lapse for twelve months will be required again to pay the regular entrance fee upon resuming Active or Associate membership.

ARTICLE VIII

Elections

Section 1.—The members of the Board of Directors of the Association shall be elected by ballot by the Active and Honorary members of the Association at its annual meeting. A majority vote of those voting shall be necessary to elect.

Section 2.—All officers of the Association shall hold office for one year from the adjournment of the annual meeting at which they are elected, or until their successors are elected and qualified. In case of vacancy occurring in any office except that of the President, the Board of Directors shall fill the vacancy for the unexpired term.

ARTICLE IX

Advisory Board

Section 1.—All Past Presidents and Honorary members of this Association or its un-incorporated predecessor, excepting those who are members of the Board of Directors, shall constitute an Advisory Board, and as such Advisory Board, they shall have the right to attend and offer advice at any meeting of the Association, the Board of Directors, or any committee.

ARTICLE X

Seal and Emblem

(To be adopted later.)

ARTICLE XI

Publications

Section 1.—The Board of Directors shall have power to authorize the publication of papers and data relating to foundry operations and the activities of the Association at any time it may see fit, and shall have published a faithful transcript of all proceedings at its annual convention, the same to be issued in bound volume form. The Secretary is authorized to sell copies of the bound volume of Transactions at a price to be fixed by the Board of Directors.

ARTICLE XII

Amendments

Section 1.—These by-laws may be amended at any regular meeting of the Association by a two-thirds vote of the members present, provided the Secretary, through letter ballot sub-

mitted to all Active and Honorary members within thirty days after adjournment, shall secure in thirty days after the submission of said letter ballot to the members, a ratification of the amendment by a majority of those returning the letter ballot, signed by those voting. They may also be amended by the Board of Directors at any regular or properly called meeting of the Board.

ARTICLE XIII

Order of Business

Section 1.—The order of business to be observed at annual meetings shall as nearly as practicable be as follows:

(1) Appointment by the President of special committees as follows:

A committee of five to nominate officers for the following year.

A committee on resolutions.

(2) Reports of Officers.

(3) Report of Auditor.

(4) Election of Directors.

(5) Presentation of papers.

(6) Reports of standing committees.

(7) Reports of special committees.

(8) Unfinished business.

(9) New business.

(10) Installation of new officers.

(11) Approval of proceedings.

ARTICLE XIV

Rules of Order

Section 1.—Roberts' Parliamentary Rules of Order shall be recognized as authority by this Association, and shall govern the deliberations in all cases not covered by these by-laws.

Annual Report of the Secretary-Treasurer

To the president and members of the American Foundrymen's Association:

Although earnest efforts were made during the past year to increase the membership of your Association beyond the 1000-mark, this ambition has not yet been realized, largely due to the large number of delinquents that had to be dropped for non-payment of dues. On July 1, 1915, 996 members were enrolled, the gain in membership in the preceding 11 months having been 213 or 28 per cent. It will be recalled that the entire membership of the Associated Foundry Foremen, in good standing, was taken over a year ago, but the total of these delinquent July 31, 1916, was 32. In view of the depressed trade condition prevailing last year, your executive board authorized the secretary-treasurer to carry the delinquent members on the books until Dec. 1, 1915, to afford them a further opportunity to pay their dues. A few members were retained as a result of this action, but its repetition is not recommended this year.

The total book membership on July 31, 1916, was 974, as compared with 973, July 31, last year. While this represents an apparent gain of 1, the delinquents are included. However, with the names of the latter stricken from the records, the loss in membership for a period of 11 months was 55, or 6 per cent. On July 1, 1916, the total membership in good standing was 918, of which 784 were Active, 118 Associate and 16 Honorary. The resignations during the year totaled 20 and 15 members were dropped for non-payment of dues. Two active campaigns for new members were carried on during the year at a cost of $540.80 and 41 names were enrolled as the result of this effort. The cash received from the new members amounted to $600 and the net realized on the campaign, above all expenses, was $59.20.

With more than 5,000 gray and malleable iron and steel foundries in the United States and Canada, the membership of this Association represents only about 20 per cent of the industry. This certainly is a sad commentary on the interest displayed among foundrymen in the attainment of progress by organized effort. The dues are much lower than those of other technical societies, and including the entertainment features at the annual meetings, the members of our Association derive direct benefits representing an actual expenditure each year of from $13.00 to $15.00, although the dues are only $10.00. It is certain that the co-operation of the members would prove helpful in increasing the enrollment and greater efforts on their part are earnestly requested.

Complete data regarding the membership of the American Foundrymen's Association, follow:

	July 31, 1916	
Active members, good standing	784	
Active members delinquent	24	
Active members carried on books		808
Associate members, good standing	118	
Associate members delinquent	32	
Associate members carried on books		150
Honorary members		16
Total book membership		974
Total membership paid to July 1, 1916	918	
Total membership, July 31, 1915	973	
Loss for year, 6 per cent or	55	
Resignations during year	20	
Dropped for non-payment of dues	15	

New members received during year 1915-1916, 50, of which 42 were Active and 8 Associate.

Accompanying this report is a chart showing the membership of the American Foundrymen's Association by years, since the date of its organization in 1896.

Finances

Notwithstanding greatly increased expenditures, it is gratifying to report that your Association continues in excellent financial condition. The committee expense during the past year has been unusually heavy, and other expenditures have shown a proportionate increase. However, on June 30, 1916, the cash resources aggregated $1,134.29, as compared with

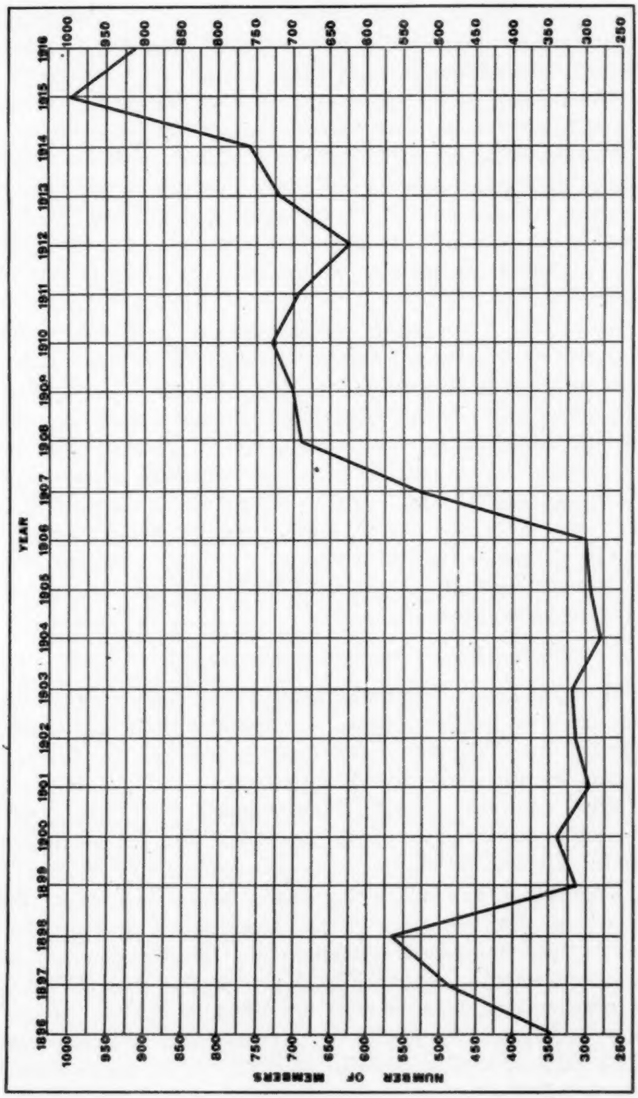

CHART SHOWING FLUCTUATIONS IN MEMBERSHIP FROM 1896 TO 1916

$1,116, June 30, 1915. The entire expense of the exhibition was defrayed without resorting to outside sources for financial assistance and the only charges made against your Association were for the expenses of the special committee of five, appointed by your Executive Board last year to carry on negotiations with the Foundry & Machine Exhibition Co., whose corporate name subsequently was changed to the Exhibition Co. These expenses amounted to $930.77 and were charged to the exhibition account. However, since July 1, this sum has been transferred from the exhibition to the technical fund of your Association.

While your treasurer is custodian of the exhibition fund, a separate bank account has been opened and the money collected in the conduct of the exhibition feature is kept apart from membership dues, admission fees and other receipts directly credited to the technical activities of your Association. The manager of exhibits, C. E. Hoyt, of Chicago, has given a bond for $5,000 which amply safeguards the Association. While Mr. Hoyt receives all funds from the exhibitors, gate receipts, etc., these are transmitted daily to your treasurer, who also is under bond and who deposits such receipts to the credit of the exhibition account.

Report of Public Accountant

As shown by the appended financial statement of Ernst & Ernst, certified public accountants, Cleveland, who audited the books of the Association, the cash balance in the treasury on June 30, 1916, was $203.72 as compared with $1,116, June 30, 1915. However, to this should be added $930.57 due from the exhibition account, which has been transferred to the technical account, making the total cash resources, at the end of the fiscal year, $1,134.29; this is the largest balance at the end of any business year in the Association's history. The total receipts from dues, admission fees, subscriptions, sale of books, emblems, etc., was $11,022.55 as compared with $8,779.70, the previous year, an increase of $2,242.85. The disbursements aggregated $11,934.83, against $7,739.53 for the year ending June 30, 1915, a gain of $4,195.30. The disbursements were $912.28 in excess of the receipts, of which $930.57 was

credited to the exhibition account and, therefore, the receipts actually exceeded the disbursements by $18.29.

In view of the change made in the conduct of the exhibition and the incorporation of your Association, the duties of your secretary-treasurer, last year, were tremendously increased. However, the burden was lightened by the hearty co-operation and self-sacrificing devotion of President R. A. Bull, Major J. T. Speer, Alfred E. Howell and J. P. Pero, who constituted the special committee that dealt with exhibition affairs, and other members of the Executive Board who always cheerfully responded, regardless of the task imposed upon them.

Respectfully submitted,

A. O. BACKERT, *Secretary-Treasurer.*

Accountants' Statement

Cleveland, Aug. 4, 1916.

Mr. A. O. Backert,

Secretary-Treasurer, the American Foundrymen's Association, Cleveland.

Dear Sir:—Pursuant to request, we have audited the recorded cash receipts and disbursements of the American Foundrymen's Association for the year ended June 30, 1916, and submit herewith summary of the cash transactions for that period:

CASH BALANCE			
June 30, 1915, as shown on our previous report			$1.116.00
Transactions for the Year			
RECEIPTS			
Dues, subscriptions, etc	$8,443.27		
Convention	2,525.28		
From sale of emblems	54.00	$11,022.55	
DISBURSEMENTS			
As shown in detailed exhibit		11,934.83	
Disbursements in excess of receipts			912.28
Cash on deposits, June 30, 1916.			$ 203.72

Cash on deposit June 30, 1916, amounting to $203.72, was verified by direct correspondence with the Central National

Bank, the Association's depository, and reconcilement of the balance reported with the balance shown by the books.

All recorded cash receipts for the year ended June 30, 1916, were traced by us directly into the bank deposits and all recorded cash disbursements were found to be supported by cancelled bank checks, together with invoices, receipts or other supporting data on file.

In connection with our audit we checked the cash received for dues, etc., directly to the members' accounts and found that recorded receipts aggregating $42.00 were not credited to the members' accounts, an exhibit of these items being included and made a part of this report.

The individual accounts of the members shown in this list of unposted receipts show their dues have been paid in full with the exception of Mr. E. S. Slatery, but we were unable to determine from the data available whether these unposted credits represented overpayments or prepayment on dues, or were payments for some other purpose. In our report, however, we have included same as receipts from dues, subscriptions, etc.

We have prepared from your records and submit herewith list of the membership dues unpaid, aggregating $500, but we did not correspond with these members to further verify our records.

No liabilities were disclosed by the Association's records or submitted to us, but an inventory of supplies, furniture, fixtures and emblems aggregating $1,332.20, and unpaid balances due on Exhibition account amounting to $930.57 was submitted to us, summary of same being as follows:

Stationery and printing	$1,012.00
Furniture and fixtures	250.00
Emblems	70.20
Exhibition account	930.57
Total	$2,262.77

Very truly yours,

ERNST & ERNST,
Certified Public Accountants.

Cash Receipts and Disbursements

THE AMERICAN FOUNDRYMEN'S ASSOCIATION, FOR THE YEAR ENDED JUNE 30, 1916.

CASH BALANCE

June 30, 1915, as shown by the Association's Records..........			$1,116.00

Transactions for the Year

RECEIPTS

Dues, subscriptions, etc..............	$8,443.27		
Convention	2,525.28		
From sale of emblems.............	54.00		
Total receipts..................		$11,022.55	

DISBURSEMENTS

Administrative salary.............	$1,650.00		
Clerical salaries..................	902.15		
Office expense....................	259.92		
Printing	3,456.43		
Postage	710.75		
Convention expense...............	2,262.18		
Traveling	708.88		
Furniture and fixtures.............	252.89		
Emblems	67.50		
Exchange	3.76		
Dues in other associations.........	125.00		
Membership campaign expense.....	540.80		
Exhibition committee account......	930.57		
Legal expense.....................	50.00		
Dues and subscriptions overpaid and returned	14.00		
TOTAL DISBURSEMENTS		11,934.83	
DISBURSEMENTS EXCEED RECEIPTS.			912.28
CASH ON DEPOSIT JUNE 30, 1916..			$ 203.72

Foundry Costs

By C. H. Scovell, Boston

Too many foundries are being directed without adequate information coming to the executives as to the cost of the product of different kinds, or for different customers; without sufficient control of expense, or adequate information regarding the cost of unused capacity; and all too frequently, without a production plan which will enable the management to get the most out of the facilities available. This is due to the widespread belief that it is impossible, or impracticable from the standpoint of clerical expense, to have more accurate information.

There are few foundry executives, however, who doubt that they could use precise information of this kind for a more efficient conduct of their operations, if only they could get the records that they need promptly and economically. It is the purpose to point out how these results, admitted to be so highly desirable, can be secured.

Objects of Foundry Accounting

There are three principal objects to be attained by operating an adequate cost and accounting practice in a foundry. First, the management should know the costs on each line of work, and therefore the profits on the product made for the individual customer. The importance of this information will vary in different communities, and in different foundries, according to the number of customers served and the amount of competition, and therefore the accuracy with which quotations must be made (as to customers this applies only to a jobbing foundry).

Second, it is all important that the foundry management should have daily reports, and weekly and monthly summaries, of the cost of foundry operations. If the volume of work is fluctuating, it is obviously necessary to watch closely the relation between direct molding and core making labor and

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Adapted from C. H. Scovell's "Cost Accounting and Burden Application," published by D. Appleton & Co., New York.

miscellaneous indirect operating costs. There will naturally be daily reports showing the kind and quantity of material charged, the ratio of metal to fuel, the amount of metal poured out of the daily melt, and the proportion of good and bad castings made. Some of this is only statistical information, and some of it, as for example, the cost of spoiled castings, becomes much more significant when reduced to dollars and cents.

Third, if a foundry is asked to make individual castings which are important as to weight, difficulty of molding, core-making, cleaning, requirements as to metal, hardness, etc., so that special attention is required at every stage, it will be desirable in such special cases to calculate the cost of individual castings (that is, individual patterns). In a jobbing foundry, handling work for different customers, the character of their patterns will obviously be taken into account in quoting a price, and if that price is uniform for all the requirements of one customer, there is not much to be gained by attempting to get costs on individual castings, except occasionally to see that one or two patterns are not costing too much above the average.

But in a foundry where the work is done almost solely for the machine shop in the same business, the only kind of cost accounting beyond averages that will be of much value is one that will get costs on individual castings, or possibly on groups, like the castings for a line of pumps, for example, in contrast with a line of gasoline engines, if both are made in the same foundry and machine shop.

From this brief survey it is plain that the object to be secured by cost accounting will vary greatly in different foundries, so that what may be an obvious necessity in one plant, will be a matter of indifference in another.

Production

An adequate production scheme is one of the essentials for efficient foundry management. It is also the framework for the cost accounting.

There should be a record of all patterns on hand, properly indexed so that they may readily be located. This record

should show the date, and from whom received, storage location, pattern number, and how many castings are to be made from each pattern. When customers' patterns are returned, the date of the return should be noted on the pattern record before the card is removed to the transfer file.

Upon receipt of an order for castings, at least three copies of the production order can be used effectively. One should remain in the production department, filed by customers or manufacturing classification, and two copies should go forward to the foundry foreman, one for his file and one as an order for patterns. A summary of these orders is kept by the production clerk, classified by customers, and if desirable for production purposes, according to weight of castings or grade of metal. A color scheme may be used in connection with production orders, different colors representing the various weight or grade classifications. A daily analysis of this summary is made by the production clerk and foundry foreman, and the production for succeeding days determined. Postings are made to this record, crediting the good castings made each day and leaving as a balance the number of castings for each pattern yet to be made.

When new patterns are received at the foundry the gross weight of castings to be made from these patterns is calculated. By maintaining the record outlined in the preceding paragraph, the production ahead of the plant can be closely estimated.

Production orders as issued to the foundry should be given serial numbers. These order numbers can be so arranged as to indicate a customer, a class of work, a pattern, or if desirable, all three.

Distributing the Labor Charges

The labor cost will be sharply divided between direct and indirect charges. Even if the direct charges are not further sub-divided, the total payroll should be separated into cupola labor, molding, core making, cleaning, pattern work, and carpenter shop. In most cases there should be a subdivision of molding and core making labor which will show the time consumed by molders and core makers against individual pro-

duction orders (and on large work a similar division of cleaning also).

All indirect labor (except that connected with the molding, core making, and possibly cleaning departments) should be charged to appropriate burden centers and subsequently distributed to job cost cards on the basis of pounds of good castings made. The indirect labor associated with molding and core making will be charged from the labor distribution to the molding or core making burden centers, and applied to costs through the hourly burden rate of these centers.

Materials and Supplies

The principal material costs in a foundry are those for pig iron, scrap and fuel charged into the cupola. There is also a considerable expense for molding and core making supplies, brick, furnace linings, and general items such as heating fuel, building and equipment repairs, etc. The disposition of these miscellaneous charges will be discussed in a subsequent paragraph.

The material charged to the cupola is the principal cost of melted metal, although the total cost of metal is composed of fixed charges on the investment in cupola equipment and raw material inventories, cupola repairs and the labor of the cupola gang. In any well run foundry there is a daily report of materials charged, and weekly and monthly summaries, from which the values of the materials consumed may be readily calculated as a charge to the cost of melted metal.

A perpetual inventory should be maintained for all materials and supplies. This does not necessarily mean that detailed stores cards should be maintained, covering all items of supplies. But separate accounts should be kept (including freight as well as purchase price and unloading costs when kept separate) for such important items as pig iron, scrap, coke, molding sand, etc. General supplies may well be grouped in a storeroom, for which one person should be responsible. The balances on hand may be checked individually as convenient. If various sections of the inventory are checked at regular intervals, a very accurate record can be maintained, so that it is

possible to prepare a reliable statement of loss and gain at the end of each period without taking a physical inventory.

It is highly advisable that such supplies as nails, gaggers, etc., be kept under stores control. Large savings have been effected by requiring the foremen of the molding and core making departments to issue requisitions for this class of supplies, which are a charge to burden in the respective departments.

Overhead charges or burden is a very important part of the cost of product in an ordinary foundry. Foundry land, it is true, is usually cheap, and the buildings are relatively inexpensive; but repairs are high, especially to cupola and equipment, if they are to be kept in good order, depreciation is rapid, and the current charges for supervision, indirect labor, and supplies, are considerable. It is highly important that the current charges should be allocated and charged to the product accurately.

The natural divisions of a foundry are the cupola, and the departments for molding, core making and cleaning. A large space may be devoted to pattern storage, and in some foundries, to a pattern shop, and a carpenter shop for repairs.

The first burden charge to each department is for rent. In case the foundryman rents his plant from a landlord, the rent chargeable to each department can be determined easily by apportioning the total rental paid among the departments in proportion to the relative areas which they occupy in the factory. In the more common instance, where the plant is owned, the expense corresponding to rent consists of interest and taxes on the land, and interest, taxes, insurance, depreciation and repairs, and possibly heat and light on the buildings. The sum of these charges determined for each building in the plant, divided by the available floor space in each, gives a square foot factor which can be used to distribute the rent charges to departments.

The Equipment Factor

Let us now consider that we have the departments clearly indicated and with the cost of the floor space used by each properly determined. Each department is provided with cer-

tain equipment necessary for the operations which it must perform. The burden charges on this equipment, will vary, because of the varying cost of the equipment, which affects interest, tax and insurance charges, and because the nature of the operations performed affects the depreciation. Charges of these various kinds are therefore based on the value and kind of equipment in each department. The sum of the rent and equipment charges are fixed whether any manufacturing operations are carried on or not, and are known as fixed charges.

Power and Repairs

The next charges are for power to drive the machinery and for repairs to keep the factory in good operating condition. The power plant should be considered as an individual unit, and the cost of generating steam and power carefully determined. The cost of operating the power plant will include, beside fixed charges, such items as labor, repairs, coal, water and supplies. Having determined the cost of power, each department using power should be charged with its correct proportion of this cost. If it is not feasible to record the power used by each department, the consumption should be estimated as closely as possible. Multiplying the horsepower hours used by the cost per hour, the power charge against each department is determined.

In a large plant the repair department should also be treated separately, and its burden known. The original estimates on the cost of repairs in departments may be made from repair department records, or from a knowledge of the repair materials purchased, the payroll in this department, and its share of the burden. When work is done for the productive departments such work should be charged to them in the same manner as it would be by an outside company. Including all the elements of cost in the repair charges puts the repair department on a fair comparative basis with outside contractors who would certainly include their burden in making estimates on the cost of work. When the charges are accumulated on the individual repair job they check the estimate in each department.

The labor cost for foremen will be part of the burden of molding and core making, and of the pattern shop and

carpenter shop if they are large enough to have charges of this kind. Cleaning labor may all be thrown together and assessed, with other general charges as a cost per hundred pounds on all the work done, but if the foundry is handling large castings which individually take several hours to be cleaned or chipped, these costs should be charged separately just as much as molding or core making labor, and in such cases the labor of foremen will be charged to burden as in other departments.

Some foundry executives may question the importance of dividing overhead or burden as above described. They may believe that average costs for metal, molding, core making, cleaning, etc., are all that is necessary, and where the product is very uniform, a fairly good control of foundry operations may be secured in this way.

All foundrymen, however, recognize the widely varying labor costs for molding and core making on castings of different weights and different shapes. It is the difference in labor cost that attracts attention, but it takes only a little analysis to show that there is a burden on molding separate from that on core making. If an accurate distinction between the cost of light and heavy castings is desired, it is essential to separate the burden costs as well as the labor costs, and charge these burdens in proportion to the work actually done in the respective departments and not as a flat average over the entire output.

Collecting Casting Costs

The elements of cost in a casting are the cost of metal at the spout, and the costs of molding, core making and cleaning. There is overhead or burden to be reckoned in connection with all these costs, and there are certain general expenses, as for power, heat and light, and supervision, that must be considered and spread in an appropriate way over the product.

These costs will be accumulated on job cards for individual production orders. It is a question of discretion as to just what a production order should cover. In most foundries it will stand for a class of product, or for an individual customer's requirements, but in some instances, as previously

noted, individual castings will be made on separate production orders.

A job card should provide for the hours and amount of core making and molding labor, pounds of good and defective castings made, and a memorandum as to the loss through returns and allowances. The hours and amount of core making and molding labor will be posted from daily labor tickets, and the weight of castings, both good and defective, from the daily production reports. A memorandum of loss by returns and allowances will be obtained from the accounting department as credits are issued.

The burden of the core making and molding departments will be applied to the corresponding labor charges, preferably on the basis of the productive hours already charged.

If the work is large, cleaning labor and burden will appear as separate items on the individual cards. Any charges for patterns, or machine work that may be done strictly as a foundry cost, will be accumulated on a separate cost card, but should be included on the cost-of-castings card under the heading of "Other Charges".

Cost of Metal

The cost of metal at the spout as accumulated in the account set up for this purpose is to be distributed to the job cards in proportion to castings made. Some managements will desire to have the material cost of metal and the cupola operating or conversion cost separately on the production orders, but if this division is made, it seems logical to go a step further and show cupola material, labor and burden all separately. The cost of the metal and the cupola operating cost are separate, of course, on the cupola report.

Just what course is adopted in this respect will depend on the view taken in regard to defective castings, and as it cannot always be known whether castings are defective as soon as they are broken out of the sand, it seems wiser to distribute all of the cupola costs to all of the castings made. Those that prove defective have a scrap value. If this is regarded as equal to the average cost of the cupola charge, the cost of the

defective castings will be merely the labor and burden (and conversion cost, if stated separately) which has been incurred in their making.

The same result can be secured by distributing the cost of metal on the basis of good castings made, and distributing the cupola labor, burden and fuel on the total weight of castings made, both good and defective.

A total will be obtained as to both gross weight and amount, from which the weight only of defective castings will be deducted, if the metal cost is charged on the basis of good castings. If the metal cost is on the basis of gross weight, both the weight and value of scrap will be deducted. According to either plan, this will leave the net weight of good castings, and the total cost of both good and defective, less the scrap value of the defective castings.

General Burden

To the cost, as above determined, general burden should be applied, representing miscellaneous foundry expenses, at a rate per hundred pounds. The main elements of burden in a foundry are to be recognized and distributed as charges on land and buildings, and for power and repairs, but after the best possible analysis of charges of this character, and their distribution to cupola, and to the departments of molding, core making, cleaning, etc., some general charges will remain for such items as general supervision, clerical labor, shipping, delivery and the costs of defective castings returned from customers (less scrap value). If the product is fairly uniform and rather small, all the costs of cleaning can be conveniently thrown in the general burden and distributed on a pound basis.

The Proper Charges for Pattern Costs

The expense for flasks and patterns, including repairs as well as fixed charges, is logically part of the molding burden, but this is sometimes thrown into general burden.

The policy of different foundries will naturally vary in respect to the cost of new patterns. In a jobbing foundry where the customers own the patterns this factor will not have to be

considered, but in a foundry making for its own machine shop, it will be considered part of the foundry cost. The general up-keep of patterns may fairly be included in molding burden, but the cost of new patterns should be accumulated on individual pattern orders, even if the final charge is to an expense account.

Patterns are an asset to a certain extent, and if a foundry is rapidly increasing its line, it is logical to increase the asset in patterns, but after a line has been fully established an increase in the assets on account of patterns should be made very cautiously, and practically all expense of this kind charged as maintenance.

Summarizing the Costs

To complete an adequate cost and accounting plan for a foundry, provision should be made for summarizing various records. The distribution of labor and materials and also the development of burden, has already been explained.

The total cost of the cupola will be distributed to individual production orders or job cards, according to one of the two plans previously outlined, and the total will be a credit to the cupola account and a charge to individual orders. A summary of the production orders in respect to labor and departmental burden will provide credits to the respective labor and burden accounts, and the total cost of the finished castings will be charged to an account called "Cost of Goods Sold", by individual customers if immediately shipped, or be transferred to a machine shop inventory. The foundry cost cards should provide for a convenient posting of shipments (weight and cost value), and to carry forward the remaining inventory to the operations of the next period. A few foundries maintain a stock of clean castings that have not been machined, but this is almost uniformly for the benefit of the machine shop rather than the foundry, and the value of such raw castings is much better transferred to the raw material inventory in the machine shop. rather than carried as inventory of finished work in the foundry.

On continuous jobs, such as work for a regular customer, or on any special work that is not finished in the month in

which it is started, there will be material, labor and burden costs in the succeeding period in addition to those brought forward from the previous period. The balances, both weights and cost values, determined at the end of each period (month or four weeks) are an inventory of work-in-process, and the total of the balances on the job cards should agree with the controling account in the general ledger. This bookkeeping agreement should be established as a matter of course every period, and a physical inventory should be taken and compared with the job cards from time to time as may be convenient, so that the management may be sure that the values and the weights are actually on hand.

Upon each cost card there should be provision for such information as the selling price, cost of goods sold, gross profit, loss on returns and allowances, and net profit. These items should be proved, by means of summaries, with the controling accounts in the ledger.

With an accounting plan in operation as defined in this article, the management of any foundry can have accurate costs on each class of castings made or sold, know profits on each customer, and have at the end of the month a dependable balance sheet and earnings statement. These results, moreover, can be secured with a surprisingly small amount of clerical labor beyond what is absolutely necessary for the orderly conduct of any business.

Foundry and Machine Shop Separate

So many foundries operate in conjunction with machine shops under the same management, that it seems in order to add a word of caution that the management should always make sure that the costs of operations are equitably divided between machine shop and foundry. This is particularly important to a company that is doing jobbing work in the foundry, besides supplying castings for its own shop. The income from casting sales will naturally be set apart, but unless special care is taken, the charges applicable to the foundry will not be known and determined with equal accuracy.

A foundry that is doing jobbing work is very likely to be in competition with other foundries and while the jobbing business may be desirable to make up tonnage, and work the foundry economically, any decision to take business of this kind or let it go should be made only on the basis of accurate information as to what it actually costs and what, if anything, the foundry will lose from unearned burden, if the outside work is dropped.

Discussion—Foundry Costs

THE CHAIRMAN, R. A. BULL.—This paper is now open for discussion.

MR. W. W. MCCORT.—Some time ago I visited a plant a little way from us and was speaking about prices. I asked the foundryman if he considered his overhead and he said he didn't have any overhead, that he owns the whole plant. I think this is right along the line that the gentleman was speaking about.

MR. S. G. FLAGG III.—In line with what Mr. Scovell has said about expense and cost accounting and in discussing this with other manufacturers, I find things to be very much as he has said. There is an article in *The Iron Trade Review* that has a great deal of truth in it. Different parts of this article may be applied by almost anybody in either the malleable or gray iron industry. I agree with what Mr. Fuller has said that it is difficult to develop a cost system that can be adapted to all plants, but it is almost impossible to make a correct price to the buyer when you do not know your exact cost and it seems to me that this is a very opportune time for manufacturers to get together and formulate such a system. I think a great many people would be surprised to learn how much it costs them to make a casting, and I think they would find their cost in many cases below their selling price. I believe the Stove Founders' National Defense Association has been working along this line of uniform cost accounting, and I hear they have obtained excellent results.

THE CHAIRMAN.—Is anyone present who is a member of that Association? I feel that there are a great many foundries whose operators are anxiously awaiting a solution to this problem, but they are waiting for normal conditions and then they will get to this matter of costs. They are all keenly interested now, but conditions in most of the foundries have, for the last six or eight months been in such a shape that it is a matter

of getting out the product rather than finding and compiling costs.

Dr. Richard Moldenke.—I think that Association's work work is rather limited to a special line of foundry work (making stoves and furnaces), and when we inaugurate a standard cost system it will have to be a good deal more flexible to care for the different lines our members are interested in.

Mr. B. D. Fuller.—The company with which I am connected has gained some valuable experience during the past year or two through changing the cost system used in the foundries and that experience points out the value of knowing the individual cost of each casting produced. Formerly, castings were divided into classes according to weight, about 10 classes being segregated as follows: One to 50 pounds, 50 to 100 pounds, 100 to 300 pounds, 300 to 500 pounds, 500 to 1,000 pounds, etc. The cost of the separate classes being ascertained, all castings within a given class were billed at the average cost of that class. This method did not prove very satisfactory as the engineers and designers, knowing that all castings would be priced according to their weight at the average cost of the class in which they landed, were not very careful, with the result that patterns were designed from which castings would frequently cost as high as 8 and 9 cents a pound and would be billed at 3 and 4 cents, one class being compelled to carry the load of another. This method did not give the true cost of the finished product. The system now used furnishes the cost of the individual casting and also rights many of these irregularities, the designer being more careful in looking to the cheapening of the casting than formerly. I am of the opinion that it is of value to any foundry to know what each item of their production is worth. This system, after it is introduced, does not require more help than many of the others.

Mr. A. O. Backert.—The Cost Committee of the American Foundrymen's Association investigated the cost system of the Association referred to by Mr. Flagg pretty thoroughly during the past year, but it was found that their system could hardly be applied to a miscellaneous line of work such as is represented by the members of our organization; nevertheless the

fundamental principles of all cost accounting are the same. In their organization a sum of $7,000 or $8,000 is paid to a cost expert who visits the plants of the members, and each individual member must pay the expert if he spends more than a certain length of time at his plant. As long as I have been coming to the meetings of the American Foundrymen's Association we have always had 15 or 20 minutes' discussion of this subject, and just as soon as the meeting was over the members promptly forgot all about it. If we do this from year to year we are never going to get anywhere. I think the time has arrived when we should get behind this movement. A recommendation was made last year requesting that we get 100 foundrymen to contribute $50.00 or 50 foundrymen to contribute $100.00 each, in order that we might start the movement, and I feel that that should be followed this year by some definite action. As Mr. Bull said, every foundryman is endeavoring to get his product out as quickly as possible at the present time because of the high prices, but the day of keener competition is coming and the thing to do is to be prepared. One of the chief reasons for Mr. Scovell's presence here this morning is to outline his experience in association work. The American Foundrymen's Association will want an expert accountant to do this work, but Mr. Scovell was too modest to refer to his experience in his address. I think it would be well to have him tell us something of his experiences and briefly outline what other associations are doing.

Mr. C. H. Scovell.—Thank you for the invitation, gentlemen. I think you will all agree that I am in rather a difficult position. I came here with a message and if you want me to, I will present it briefly. I think it will serve no purpose if I mention names, but with that reservation I will try to tell you pretty frankly what the experience of several other associations has been.

One association had a very real interest in this matter, and it devoted several successive monthly meetings to the discussion of this work. The association was small, less than 50 members. Nearly all of them were represented at the meetings and nearly everybody talked, and while at first this appeared

to be a disadvantage, as the thing worked itself out, it proved to be an advantage because they all came to understand each other. It appeared toward the close of their first meeting that one man among their membership felt that he had a cost system that was markedly superior to anything else anybody had told about. Later the fact proved to be that he was merely a better talker than anybody else, but he was very sincere and the other people accepted his views. It was agreed he should get out a list of questions in respect to the cost of the product in the terms of this cost system, and that was supposed to be a great move in the right direction. The questions went out and the answers came back. Some of the members did not thoroughly understand the questions, but as it was talked over in the meeting they came to the conclusion that they would try to compare costs on another plan. The result of that attempt brought them to the conclusion that they could not get very far unless they had the thing studied out for them by a professional, and after some debate our firm was selected to do the work.

In that case we visited every plant in the association. That study brought out, among other things, that the cost system on which they had made their first attempt was by no means the best among the membership. There were at least three others in the association markedly superior in every way, in my judgment, and a good many that were at least the equal of the one they had first used for a basis. That investigation also brought out the fact that in respect to the cost of material they were fairly near a common ground. The labor cost was also within reach of comparison, as they worked largely on a piece work basis. Some that did use day work had the labor cost so well established that it could be compared to piece work prices. But that was the end of anything that was alike for all practical purposes.

The overhead, which a member here this morning has spoken about, usually amounts to nearly as much as the labor. In that industry the overhead was, on a rough average, about 150 per cent of the labor cost. In the individual plants they handled the overhead in every way, good, bad and indifferent, and I don't need to say that as it was such an important propor-

tion of the total cost they obviously did not understand each other at all.

Unlike your industry, their competition was countrywide; your competition is more or less local, the foundry operating here in Cleveland is not competing with the foundry in Springfield, Mass. But you are just as badly off here in Cleveland, or in any other center. If you have 20 or 25 competitors within range, you have the same kind of thing that these people had and the same difficulties in making sensible prices.

The results of our studies were reported to the association and the outcome was, I am frank to tell you, perfectly typical. A leading manufacturer who had very little to say in the previous discussions, rose at the meeting at which the report was read and said, "Gentlemen, I don't know what you other people are going to do, but we are going to have Mr. Scovell come down to our plant." That made me feel very good, and I thought I was going to get a lot of orders; but you may as well have the truth, gentlemen, up to this date we have not had a single blessed other member ask us to do a thing along this line. When I started to find out why, I was met with the very frank statement to the effect that as one member had come forward and said he would do it, the other members of the association are waiting to find out if we have done a good job. If they find we have, they will follow suit; in other words, they were going to let him be the "goat". Now this manufacturer is marketing between two and three million dollars worth of products a year. He has got something for his expenditure and he knows it; and some of his competitors are waking up.

One of the most significant things about this is that this very man had had visitations and professional advice from at least three other people within the last three years and I flattered myself that he knew the genuine thing when he saw it. (Now that is not modest at all, is it, gentlemen?) There is a terrible inertia, a disinclination to get under way in undertakings of this kind, but I believe that this winter more of the members of this association are going to get under way, because this man is very prominent in the association and they see what he has accomplished by installing this system.

That is the story of one association. The other association was smaller than the first. Their competition had become so keen that they had very hot arguments at their meetings. They had not come to fisticuffs, but they did have some terrible hot words. There was no limit to the personal abuse they visited on each other for alleged price cutting, and then they would cool down and realize that abuse and recrimination was not getting them anywhere. They agreed that they had not made any progress during the past five years, that they had just called each other names.

Then they realized that they were business men, and that they were associated together to make more money, and that they should understand each other. We reported on a uniform cost system and at the present all but two of the members have taken up work with us. They are accordingly understanding each other and reaching common terms. Some have very freely invited their competitors to come to their plants. The leaders have opened their records to their competitors, and one man told me that it was the most money-making thing he has done in five years, because the only thing that stood in the way of his success was the foolish price-making of somebody else, which would force him to lower his price and throw away his profit.

We are starting in on work for another association and their program is to operate along the lines I have recommended to the foundrymen. They are furthermore offering a personal inspection of the plants, so that the individual members can have their own conditions inspected and compared with the standard which the association has set up. The preliminary work is to be paid from a fund to be raised by the association. If a man has put money into it, he will naturally say that he might as well get something out. By paying a very little bit more he can get a great deal out of it, and I think that this association is going to get further ahead by using this scheme than a great many other associations will.

American employers are almost universally facing demands for better wages. There is an awakening public demand to find out the returns of those who own an industry, and those who work, and the demand is coming very strongly from the work-

ers for a larger part of your profits. Mr. Knoeppel is going to talk to you about profit-sharing, and I suppose he will go into that very thoroughly, but I want to tell you men that if you don't keep up with modern business methods you will be in the business graveyards. There is no choice, not because I say so, but your business life depends on the profits you are making. You can't afford to make castings at a loss. As Mr. Fuller said, if you make castings for your various customers, and do not keep track of your costs, you cannot tell whether it is profitable to keep a certain man's work or not. Mighty few of you can tell that, and you know that ought not to be the case.

It is not a theory, but an actual condition that confronts you. You have got to educate your competitor, and, judging from Mr. Fuller's statement you have got to educate yourselves. We have learned something from our association work, and the paramount thing is to get the members interested and have them take hold. If you just come here and talk this thing over and go home and forget it, you will not get anywhere. You have had other people talk to you before this, and no doubt others will talk to you in the future, but if you are going to get anywhere some of you should voluntarily subscribe a certain sum for this work and get it started.

Mr. J. C. Wilson.—A good many statements have been been made this morning about cost accounting systems and it seems to be a pretty general idea that cost accounting is not necessary in good times when the margin of profit is very high, that at present it is simply a question of getting the tonnage out more than of getting down to details. Of course we are all in the foundry business, not to make castings, but make profits, and I have found in my particular line that during these unusually good times that a cost accounting system is more important to us than it is in bad times, because in very good times one has an opportunity to use a little judgment in the selection of his contracts. For instance, I know of cases where steel foundries have been able to put a certain amount of their tonnage into shell steel at a very much greater profit than in ordinary castings; had they not known the cost of these ordinary castings they would not have been able

to determine that they could make a greater profit by turning their attention to shell steel. I think it is in times like these that we should put in such a system.

The Chairman.—Are there any further remarks? Mr. Backert, I believe you have a motion to make.

Mr. A. O. Backert.—I would like to introduce a resolution authorizing the Cost Committee to investigate some of the various systems that have been tried out by the different associations, and to report its findings, within the next two or three months, to the Board of Directors of the American Foundrymen's Association; also to empower the Board of Directors of the American Foundrymen's Association to carry out any plan which seems most expedient to make most effective some definite cost system for foundrymen. I think that only by so doing, we can make any headway. In the past we have always reported progress in this work, but what we want now is action, and while it will not entail any expenditure of the funds of the American Foundrymen's Association, it means that the Cost Committee and the Board of Directors can ask the individual members who want to co-operate to raise a fund to carry on this work. Mr. Chairman, I move.

The Chairman.—Gentlemen, it seems to be the opinion that we ought to get right down to business on this subject at this time and we will now vote on this resolution offered by Mr. Backert and seconded by Dr. Moldenke.

Mr. A. O. Backert.—This resolution is intended to put some power behind this movement; a large amount of language has been spilled during the meetings of the American Foundrymen's Association on this question for the past 20 years. In other words, we want to get back of this thing and do something; we want to authorize this Cost Committee to investigate the work that is being done along similar lines by different associations and if necessary to go to Washington and interview Chairman Hurley of the Federal Trade Commission.

The motion was carried unanimously.

Report of the A. F. A. Committee on Foundry Costs

During the past year the Committee on Foundry Costs held one meeting for the purpose of considering the recommendations contained in the report presented last year. The plan outlined to facilitate the introduction of the uniform cost system presented last year, follows:

> To promote the adoption of a uniform method of keeping costs among the members of the American Foundrymen's Association and the foundry industry at large, the employment of a cost accountant is recommended who is in thorough harmony and sympathy with the methods outlined. Ways and means for meeting this expenditure is the subject for the consideration of your executive committee, but as a suggestion, it is recommended that 100 foundrymen guarantee a fund by the payment of $50 each, or 50 foundrymen guarantee to pay $100 each during a period of one year. Each of these foundrymen then would have first call on the services of this cost expert and during the year he could remain at each of their plants a sufficient time to teach the accountants the basis or theory of the system recommended. Also, general meetings could be held in the various localities which the cost accountant visits and the system further explained so that more foundry competitors would be interested in the adoption of the uniform cost theory. In making these suggestions it is realized, of course, that the association has not sufficient funds to defray the cost of an expert's services, nor would it be fair to the membership at large to employ such an expert for the benefit of the comparatively few whose plants he could visit within a year. Therefore, the plan has been devised of underwriting a fund to defray the cost of the expert's services and his expenses.

The employment of a cost expert was carefully considered, several propositions having been presented to your committee by men qualified in foundry cost accounting. Including the salary and traveling expenses of such an expert, it was estimated that a fund of at least $5,000 would have to be raised to carry out the foregoing recommendations the first year. However, in view of the activity of the casting plants and the general prosperity prevalent throughout the industry, it was the con-

census of opinion of the members of this committee, that it would be exceedingly difficult to enlist the interest of foundrymen in furthering this work this year and it was decided, therefore, to make no effort to raise this fund, but to defer action and to seek further instruction from the members at the annual meeting regarding the advisability of carrying out these recommendations during the ensuing year.

Several cost accounting firms now are specializing in the introduction of uniform cost systems, and it is probable that some arrangement might be made with one of these companies on terms more favorable than could be obtained by the employment of an individual cost accountant who would devote his entire time to the interests of the members of this Association, who would underwrite this fund.

Attention also should be directed to the work that is being done by the Federal Trade Commission along cost accounting lines. It is the intention of this Commission to have a staff of expert cost accountants affiliated with it, qualified to introduce uniform cost systems in various industries. In the general campaign that will be carried on, the foundry industry will be included and it might be advisable to await the action of the Federal Trade Commission before attempting to carry out this work as an Association.

B. D. FULLER, Chairman
E. F. FELTHAUSEN
H. J. KOCH
RAY TANNER

Discussion—Report of A. F. A. Committee on Foundry Costs

MR. A. O. BACKERT.—The Federal Trade Commission, of which Mr. E. N. Hurley is chairman, has done more to promote interest in accurate cost accounting methods among manufacturers than has heretofore been attempted by any other governmental body. It is the belief of the members of this commission that when manufacturers know their costs that selling prices will take care of themselves, and that to a large extent, cut throat competition thereby will be eliminated. In many addresses delivered by Mr. Hurley, he has pointed out the deplorable conditions prevailing among American manufacturers and business interests generally in so far as cost-keeping methods are concerned, and it is his belief that this is the first essential necessary towards the elimination of that kind of competition which means the ruination of many business men. The Federal Trade Commission has issued a number of bulletins of the subject of cost accounting which have been distributed quite generally and the members of the American Foundrymen's Association will receive copies of all these bulletins since a list of the members has been furnished to Mr. Hurley. The Federal Trade Commission already has the co-operation of a number of expert costs accountants and while accounting and cost-keeping in the metal trades have not yet been investigated, it is possible this subject will come up for consideration in the not distant future.

THE CHAIRMAN, R. A. BULL.—It is gratifying to hear that the Federal Trade Commission has taken such an interest in this proposition, and I think it would be advisable to leave this matter of costs to the committee which should be continued to work out such a plan of action as seems advisable in view of future developments of the trade. I don't know that a motion to that effect is necessary, but it might be understood if there are no dissenting voices.

Profit-Sharing as a Factor in Preparedness

By C. E. Knoeppel, New York

In all of our discussions of the important question of "industrial preparedness", there has been little said with reference to *adequate incentives.*

In an address before the Academy of Political Science of New York on "Compulsory Service and Industrial Preparedness", I stated that compulsory service ceases to be compulsory when there is a desire and a willingness to serve and that our problem was to find out how to induce this willingness and desire. Likewise in industrial activities, this willingness and desire must be induced—*it cannot be forced*—and to do this incentives in some form must be devised and provided.

A worker laughs when he hears someone speak of the "joy of work". In business, however, men will work for 16 hours a day if it is found necessary. For the love of the game? Yes, to some extent because to "play the game" is essential to success, but the real reason is the incentives behind it all, warranting concentration and hard work for long hours.

A worker goes home at night and he has earned a day's wages. Tomorrow is another day and he will earn another day's wages—if he is not discharged or laid off; if he does not quit; if he does not die or is not taken sick. His life is a "by-the-day" proposition. Of course this is conducive to freedom from worry, contentment, an optimistic attitude and the like. On the other hand, the business man or executive goes home at night knowing that tomorrow, next week, next year, he has something to work for—*his business.* He may be worried because of business conditions; things may not be breaking just right but he feels that this is all part of the game and that he is playing with what is actually his.

Incentives and Lack of Them

No, I am not a socialist. I am not advocating an equal distribution of things, nor a giving away of anything that isn't

warranted by the conditions. I am simply trying to picture the difference between incentives and the lack of them.

In industry the manufactured product, in the last analysis, is labor, for the material that is bought by one concern and processed by labor, represents the labor spent on other material by another concern, and so on through to basic processes. With this thought in mind it should stand to reason that the man who serves his employer best is the one—

1.—Who works efficiently rather than strenuously.
2.—Who is not forced nor driven.
3.—Who has faith in the management.
4.—Who is not treated in the manner that induces worry and doubt regarding the future.
5.—Who does not have to shoulder responsibility that rightly belongs to the management.
6.—Who knows that the question of exertion and fatigue receives due consideration by the management.
7.—Who works under the right working conditions.
8.—Who realizes that the management is interested in his welfare.
9.—Who works in a pleasant, congenial atmosphere.
10.—Who receives something in addition to wages for time spent at work, which represents, to him, his skill, co-operation and extra efforts.

These are real incentives and until the time comes when they are all provided, there will not be the right relationship between capital and labor.

Business Conducted for Profit

Business is conducted for profit. Material is purchased and brains and muscle are utilized in converting this material through the medium of plant and equipment, into a finished product at a cost that will be less than the price secured. The material, plant and equipment represent an investment. Inasmuch as it is impossible to get results from the capital investment without the human investment, these conclusions seem logical:

1.—That capital investment is entitled to a fair return on the amount invested, in the form of interest for the use of money.
2.—That brains and muscles are entitled to a fair return for the efforts expended, in the form of salaries and wages.
3.—That after the capital and the human investments have received their fair returns, the balance, after providing for contingencies, depreciation, bad debts and the like, should be divided between both capital and human investments, on some basis that represents the reward for the results both investments were instrumental in securing.

You say this means profit-sharing. Let us look at it as "savings-sharing", for profit-sharing on the right basis should induce the desire to effect savings which would be divided between capital and human investments.

You say, "Suppose there are no profits or savings to divide?" My answer is that proper methods and the desire to share in the savings will, in the majority of cases, lead to savings to share.

Let us not look at this subject, however, without considering the thorny side of things. In a survey made by the Welfare Department of the National Civic Federation, it was found that of the companies whose plans were analyzed, *almost one-third were successful and the balance failures,* which would seem to indicate that no further thought should be given to the matter.

Let me paint you a few pictures before passing judgment, in an effort to determine a real basis for profit-sharing.

Two molders are working side by side, each drawing the same wages, we will say, and both in the employ of the company for about the same length of time. One of them is a careful, painstaking and conscientious man, who gives his employer the best he has, his contribution being maximum production with a minimum of rejections. The other is not so careful nor painstaking, nor conscientious, putting up only enough work each day to "get by" and while having scrap from day to day, does not have so much as to cause his dismissal. The one displays interest in his work. The other doesn't. The one does his best; the other believes in doing no more than he has to. Dividing profits or savings between these men gives them an equal amount and the effect is detrimental to both. The conscientious man smarts under what he feels is an injustice in that he gets no more than the other man, for even though he says nothing about it, he knows in his own heart that he has earned more for the company than the other and consequently feels that his share should be greater. The man not so conscientious knows that he has, without exerting himself, to the same extent as his fellow workman, secured as much in the sharing, and naturally feels that there is no need for him to do his best.

The result is that both say—"What's the use?" This establishes an important law as I see things—*sharing in savings or in profits should be in proportion to individual attainment.*

Purpose of Profit-Sharing

Now for another point. The worker is a "by-the-day" thinker, for all his life he has worked from day to day, getting his money from week to week or twice each month. He lives in the immediate as far as his work life is concerned. The purpose of saving or profit-sharing is to induce interest, foster a desire to do the best that is possible and to get the worker to take every advantage of his opportunities and the facilities furnished him. People are prone to count their chickens before they are hatched but if the hatching is too far in the future, they quit counting. So with workers. They will work for savings or profits if the division is more or less immediate, but if you attempt to keep them interested on the basis of promises that will not materialize for six months, you will find their interest on the wane and again the result is—"What's the use?" This establishes another law—*profits or savings should be shared at such frequent intervals as will insure interest being maintained.*

Another point has a bearing on this important question. Men are working under a profit-sharing plan. They are expecting that there will be profits to divide and then, we will say, due to a bad year the earnings are insufficient to warrant sharing them with the workers. Now imagine the feeling of a worker trying to do his best, realizing that he have given his employer the best of service which should, as he sees things, entitle him to something above his wages; suddenly confronted with the situation which he expresses as "nothing doing". Again the result is—"What's the use?" This situation, to my mind, establishes still another law—*something should be given to the worker regardless of the company showing in return for the interest and effort expended in anticipation of sharing in profits.*

What's the Use?

Still another point. Workers may share in the profits or savings made, but if they see evidences of extravagance, of care-

lessness, of waste on the part of the management; of factors they cannot control like bad debts, buying at high prices due to faulty purchasing, faulty selling, inefficient equipment, poor working conditions, faulty methods, you are confronted with the same condition—"What's the use?" This establishes the fourth law—*savings or profit-sharing should be on the basis of factors within the workers' control.*

Failure of Profit-Sharing Plans

There are, of course, other points that can easily contribute to the failure of a plan of profit or savings sharing, as for instance—

1.—The attitude of organized labor.
2.—The fear of over-production and the introduction of machinery.
3.—Suspicion on the part of labor as regards motives and intent.
4.—Failure to properly understand the plan in use.
5.—No say in determining the plan by labor.
6.—No way of determining that the profits are as stated by the management.

I believe, however, that if the four laws are recognized and lived up to, the plan that may be decided upon can be made successful in the majority of cases.

Let us restate these four laws and see what can be done towards working out a plan based on a conformance to them:

1.—Sharing should be in proportion to individual attainment.
2.—Frequent intervals in dividing.
3.—Division regardless of company showing.
4.—Division should be on items within the workers' control.

But you say—how are we to determine individual attainments? How can we divide savings or profits when we only know once or twice a year what our real condition is? If we suffer a loss we have to stand it, why shouldn't the men? Why should we give men a division on items only within their control, when our real showing is on all the items which influence profits and savings?

These are fair questions and demand consideration. In attempting to do this let me give you a fundamental principle:

Unless the plan you establish is based on right and justice; unless there is something of the "give and take" to it; unless

there is co-operation between the men and the management in working things out; unless the men can feel that they have some say in it all, by all means save your energy and your money, for unless this fundamental is considered, the plan is doomed to be a failure before it is even put in operation. Remember that two-thirds of the plans have proven failures and what you install must be on such a basis as will insure success at the outset.

Let us consider the laws in logical order:

Individual Attainment

Much has been written and said on this phase of the work, but I contend and my experience has shown that standards can be set that will determine the efficiency of each man, such as molder or coremaker, or groups of men, such as cleaners or laborers. Where they cannot be accurately or scientifically set, fair estimates can be made, not by looking at a pattern and saying, "Oh, this will take about five hours," but by setting down the known elements and estimating the time for each element as indicated by the following:

Operation—Estimated Time, Minutes

Laying board and pattern.
Placing drag.
Riddling sand.
Shoveling heap sand.
Ramming drag.
Laying bottom-board.
Clamping and rolling.
Placing cope side of pattern.
Placing cope.
Placing gaggers.
Ramming cope.
Lifting cope.
Finishing mold.
Filing, setting and securing cores.
Closing.
Clamping and placing weights.
Total allowance.
Grand total.

In this connection I wish everyone could read "Magic of Motion Study", by Reginald T. Townsend, in the July issue of *The World's Work,* describing the wonderful work which has been done by Frank B. Gilbreth, of Providence, R. I., in

reducing to a positive science, the work of motion study. My grandfather was a molder, my father was a molder, I started work as a molder, and while I have studied many lines of work since I left the floor, like coal mining, glass work, candy, structural iron and the like, I know of no trade that lends itself more readily to the work of motion study than the foundry industry. Whether ramming, finishing, setting cores or cleaning castings, the work is largely one of motions which can be studied and standards determined as a result. By comparing actual performance with standards determined, individual attainment can be ascertained which will serve as the basis for rewarding the workers.

Frequent Intervals in Dividing

It is obvious that a concern that does not know its exact condition until the end of a year, cannot, of course, divide savings or profits at frequent intervals during the year. The fact remains, however, that the accounting and cost systems can and should be arranged on the basis that would enable the management to secure monthly profit and loss statements, from which it could be determined what had been saved in reduced costs or made in profits. Even if no monthly payment was made to the men they could be advised regarding the showing, along with an idea regarding what they would make and the payment made every three months, or at least twice each year. The knowledge that they had earned something with an idea regarding the amount would do much to keep the interest of the men at the right point.

Rewards Regardless of Company Showing

It wants to be remembered that all the men have to look forward to is their wages, which they, of course, receive regardless of any loss the company may sustain. At the same time the owners of the company have the future to look forward to. They own the business, the investment is theirs and losses sustained at one time may be made up at another time. They can borrow money; the men cannot. They may have a surplus. The men haven't. They may have a reserve capital which the

men do not possess. After all, the big thing is to secure the co-operation of the men and a striving for rewards and their not getting them will do more than any other one thing to make them lose heart and say—"What's the use?" Some provision should be made to let the men share in some form of reward, regardless of the company showing.

Items Within the Workers' Control

You can well imagine the effect on the average worker's mind, of doing sufficiently well on things within his control to entitle him to rewards only to lose them because of what happens to items not within his control. The men can't and should not run a business. They are engaged to do certain definite things and the idea of giving them a share in savings or profits is to get them to do their best with reference to these certain, definite things. The men might do their part of the work, but because of poor purchasing, or inaccurate costing, or other causes, losses would wipe out the gains the men ought to make. It seems, because the men are not to blame for the losses and because they have done what would otherwise entitle them to rewards on the items they could and did control, that they should be rewarded.

Delays Beyond Workers' Control

Some years ago in a shop paying their men on the bonus plan, some men were delayed, due to causes beyond their control. The time set, we will say, was 10 hours, and that the men did their part of it in 10 hours, but because of the delays of two hours the total time was 12 hours, or an efficiency of 83.3 per cent. Should the men stand this delay or should they receive their reward and the inefficiency be charged to the management?

Suggested Plan

Under any plan of profit or savings-sharing, the regular wages paid to the men in the district should be paid to the men working under the plan.

To base the rewards on individual attainment, fair standards should be determined by motion study or estimates based on

detailed analysis and a sliding scale should be paid the men over and above their wages based on their attainment as follows:

For 100 per cent efficiency, 20 to 25 per cent on wages.
For 90 per cent efficiency, 10 per cent on wages.
For 80 per cent efficiency, 5 per cent on wages.
For 70 per cent efficiency, 2 per cent on wages.
For 60 per cent efficiency, 0 per cent on wages.

As this premium would be paid on what the men actually do, rewarding them as outlined, would take care of the two provisions, rewarding them on items within their control and regardless of the company showing.

After rewarding the men as outlined and after taking care of depreciation, bad debts and reserves and giving capital investment a fair return on the money invested, the balance should be divided between the capital and labor investment. *The amount to be given the men should be paid on wages plus premium.*

If you pay men wages, plus premium or bonus based on individual attainment and on top of this give them an additional amount representing their share of savings or profits, *you have provided real incentives;* for men will then be anxious to do their best, because high efficiency will result in increased wages. Increased wages will mean larger premiums and a large wage and premium total will mean a greater share on the savings or profits.

Distribution of Savings

In arranging to distribute savings the following could be used to advantage:

Divide the business into departments and charge them with the direct labor costs, indirect labor costs and the proper share of overhead expenses, chargeable to the producing end of the business. Credit these departments either with what the costs were at the time the plan was started, or with fair estimates covering the work done from the standards determined upon. This means that the departments would be charged with actual times or costs and credited with estimated or standard times or costs. The difference would be the savings or waste. Incidentally, the men should have some say in the settling of these

estimates or standards if their full and hearty co-operation is to be secured. In case piecework was in operation at the time the plan was introduced, which would naturally have to give way to an hourly base of wage paying, the pieceworkers could be paid, out of the savings, the difference between the day rate and what their hourly rate on piecework was for a period of four to six months previous to the installation of this method of reward.

As can be seen, this, with reference to the business as a whole, is the same kind of a plan as applies to the men in giving them a premium or bonus based on individual attainment. The total actual and standard or estimated times and costs covering all the molders would be the charge and credit for the molding department and the difference would be the waste or saving. The total actual and standard or estimated times of all departments would give the charges and credits for the business as a whole and the difference would be the waste or saving. One-third to one-half of the net savings should be credited to the men and paid to them on the basis of total wage and premium earnings, as before mentioned. Common labor and the foremen should be included in the division.

Another Plan

Another plan, would be after capital has received its legitimate earnings and taken care of contingencies and labor has received its regular wages, any surplus should be divided between the two *in proportion to the earnings made by capital and labor*. If in a business capitalized at $500,000, the earnings amounted to $100,000 in a year and the earnings of labor were $100,000, any surplus should be divided—"fifty-fifty"—as the saying goes. In other words, after deducting 6 per cent as dividends, $30,000 and $25,000 for contingencies, reserves, etc., or $55,000, the surplus would be $45,000, of which $22,500 would go to labor and $22,500 to capital.

Other plans could be described, and details outlined, in fact a good sized book could easily be written about profit-sharing. After all, the principles cover far more than methods. If the principles are right, the methods cannot go very far wrong.

Discussion—Profit-Sharing as a Factor in Preparedness

THE CHAIRMAN, R. A. BULL.—In Mr. Knoeppel's paper he has covered the subject in a very interesting way; this is a subject worthy of very serious study and I hope you will show your interest by communicating with Mr. Knoeppel. We would be very glad to have some discussion on this paper. Lack of discussion does not show lack of interest, but lack of opportunity for detailed study of the question.

DR. RICHARD MOLDENKE.—Will you give us, in a few words, the reason for two-thirds of the profit-sharing plans failing?

MR. C. E. KNOEPPEL.—In the first place, one of the reasons is the attitude of union labor. They seem opposed to the thing because they have very little to do with the plan or they fail to understand it, or they misjudged the motives of the management. Another strong contributing reason has been that profit-sharing is not based on individual attainment. I spent three months in a very successful plant, where they had a very successful application of profit-sharing and I talked with the men and one of them said, "There is a worker over there who has been here as long a time as I have and he gets the same money as I do, but I know he is not as efficient a workman as I am." I said, "Can you prove it?" "Yes sir," he said, "The records will show that." I analyzed the records and found what he said was true. Now here we have a condition where the efficient man is getting the same as the inefficient and the efficient man feels that he is not getting as much as he ought to, there is no incentive for him to work harder; the inefficient man says, "What's the use, I am getting as much as that other fellow." Another profit-sharing plan is to offer a reward every six months or a year, if the company has made sufficient profit, but the men soon loose interest. Most of us are workers or have been workers in foundries, and we know

that it was a day by day existence, and if the firm tells the man that they will divide profits with him every six months, this man will soon lose interest. There is also the plan of awarding profits in proportion to the time it takes to do a job. For instance, a gang is supposed to do a certain thing in 10 hours. I know of one case where such a piece of work was supposed to be done in 10 hours and it took the gang 12 hours to do this particular piece of work, two hours of which were wasted by them for reasons absolutely beyond their control; they could no more help it than you could. The company said they were not entitled to the profits, because it had taken them 12 hours to produce, but in reality they had done the work in 10 hours, therefore, they bettered the result, but they were refused the reward which was lost through conditions beyond their control. You know in foundry work men often have to wait for different parts of the work to be done; they have to wait for the coremakers, etc., and the men will see that the management is a little careless and will think that there will be no profits to share at the end of the six months and will become dissatisfied. I think these are the principal reasons why so many of the profit-sharing plans fail.

DR. RICHARD MOLDENKE.—I suppose you can sum it all up in the one word—*Injustice*.

MR. O. J. ABELL.—Another point is the question of the sincerity of the profit-sharing plans. I think that sometimes they are put into effect to obtain greater profit for the employer than for the dispensing of the profit among the men and until a profit-sharing basis of absolute sincerity can be established, I do not think it will find success among the men.

THE CHAIRMAN.—Sometimes I think it is a difficult matter to convince the employe that the employer's motives are sincere.

DR. RICHARD MOLDENKE.—One point that struck me very forcibly was that in Germany the great bulk of the workers have more than they do in this country and yet there is more Socialism among the workers there than in any place in the world, and I thought perhaps that there is something in Germany, such as the governmental pension system, that may

account for this. As I understand it a man starts to work as a youth and 30 years after starting he gets a pension from the government, that is, the government pays one-third, the employer pays one-third and the man himself pays one-third; but the employer really has to pay two-thirds and the government pays one-third, but in this country we are not fraternal and it is hard to get this thing started.

Mr. C. E. Knoeppel.—One concern, at the present time, is figuring on a profit-sharing plan by which it will issue stocks or certificates, but I have talked to one or two of the workers and they don't understand the thing; they say, "We don't understand this scheme, we don't want their certificates, we want the money."

Mr. T. J. O'Brien.—I would like to ask Mr. Knoeppel what proportion of the company's profits he would recommend giving the employes?

Mr. C. E. Knoeppel.—I don't believe I would be able to state what proportion of the concern's profits should be divided with the workmen; it can be divided fifty-fifty after you have provided for interest on investment, taking care of contingencies, insurance, etc. I know of one case where they divide 25 per cent of the profits among the workers. Of course it would have to be different on the day work and piecework, but I think it is a matter that would have to be left largely to the individual management from the standpoint of what they consider to be a fair distribution. If you can give them the profits on a fifty-fifty basis, do so, or if you feel that 20 or 25 per cent would be sufficient, use that as your standard, but they should have some chance to check up so they can see the company is being fair with them. However, you can't give them just any old thing and expect them to stomach it, they will want you at least to demonstrate they are getting their proper share.

Mr. George Fisher.—I have had considerable experience and I would like to know if Mr. Knoeppel has any idea what would be fair and equitable. I read with considerable interest something that was published by the Industrial Commission of New York.

MR. C. E. KNOEPPEL.—You will find in this paper, which I have written, a general scheme for the working out of the principles. You will find specified plans that might apply to the profit-sharing. You must pay particular attention to the first rule, that you should set before the workman some fair standard which would enable them to earn something besides their wages in proportion to their production. You should have a cost system as Mr. Scovell has outlined, as in that way you know what you have made and lost every month. I know of one case where they are giving the men 25 per cent of the profits. They called in the shopmen and the foremen and told them about it, that they were going to set a standard and pay premiums, and I think that system is going to work out very well.

MR. JOHN H. COCHRAN.—I have a few words I would like to present on this subject; some of my remarks are not going to suit a great many of the manufacturers, but I am a member and have been in the manufacturing line and think I have a perfect right to say what I think. I have served my time in metal work in gray iron shops in different parts of the country, both large and small, and at the present time I am the proprietor of a brass foundry doing a good business, employing about 18 men. What I have got to say has been obtained from actual experience in getting around the country, and one of the great troubles, one of the chief causes of trouble between the capitalists and the laborers is the refusal of the employer to give the man a decent day's wage; that has applied more so in the past than during the present time. We all know that during the last year or so, wages have advanced to a great extent and they should, because the man doing the work in the shop has the same desires in life as the owner; he wants to wear good clothes; he wants good food; therefore, why should he not have the money and how is he going to get it? He is the man who is producing and, therefore, he is entitled to it. Now it seems to me that there is a scheme on the part of a good many of the manufacturers in the country that I have worked for, it seems to be their idea to pay the lowest rather than the highest wage, and when I got into business for myself I deter-

mined I was going to follow out the opposite policy, to pay as much as I could, to pay the highest rather than the lowest wage. I have been through all the hardships that the men in my shops have to go through; I was in the United States army and in other lines, and I know that the hardships in those lines are not one, two, three with the hardships in the foundry. I think that the gentlemen present, as well as all those interested in the foundry business in general, ought to pay the men a little more and by doing so they would not hear of so much dissatisfaction and discontent among the employes. I make it a point in my little business to get the men together once a week or once every two weeks; we have a little party, a luncheon and we talk matters over. I say, "Boys, where is there any place we can improve things; do you know of any ideas or any advice that you could give me as to loss of time in operation or anything that we ought to do or can do to help matters? It is entirely up to you; if you fellows want more pay you have got to work so there is more production." In that way the men become interested in their work and when a man shows that he is doing his best, I pay him according to his production. Now another thing I have noticed, very often the workmen will look at their employer and say, "Look at that fellow; he has got a touring car, a big house, look at the way his daughter dresses and think of his son, he can send him to college; and look at me, I have got to live in a ten-dollar a month house." I think, gentlemen, there is a lack of human kindness—that is the keynote of the whole proposition—and I think the time is coming when you will have to agree to give your men more money. I am not talking from the standpoint of a Republican or a Democrat or a member of any other party, but I say this, we have got to pay the men more money, because if we do not there is going to be friction.

The Chairman.—I would like to have Mr. Knoeppel answer this question, is not the Federation of Labor opposed to a profit-sharing system?

Mr. C. E. Knoeppel.—The Federation of Labor is opposed to piecework and to the bonus system, and whether you agree

with me or not, I am convinced that their opposition to piece-work and the bonus system is due largely to the attitude that the employer has taken until labor has become suspicious and the same would also apply to the profit-sharing system, so that the attitude of labor is also opposed to the profit-sharing system. Now let me say that the manufacturer is the man who is taking the chance. He has got the money and the money of his friends put into this proposition, and he wants a return on that. He can't afford to pay the highest wage unless the men are going to turn around and help him safeguard that investment and the investment of his friends. I have been in plants that are strongly unionized. I have had experience with the men in the coal mines and my experience has been that the men are against anything until they thoroughly understand it. I know of a strike that was pulled off in a plant that was attempting to put in a bonus system because some bright young fellow figured that they ought to cut rates because the men were making too much money and there was a strike.

A Member.—What is the attitude of the labor leaders toward this proposition?

Mr. C. E. Knoeppel.—I have talked with a great many of them and one labor leader, whose name I am not free to mention, said that there would be no difficulty if all employers were as fair to their employes as the plans I have laid out indicates, but that he would not want to be quoted because of the trouble it would stir up in union circles.

Mr. John H. Cochran.—When a piece-work system is installed, it is supposed to be for increased efficiency and also to give the men a better wage. When I was working around the country in different shops I worked on piece-work and found that I could make say $4.00 a day, what I considered a good wage. Now then, if I happened to reach $4.50 there would be sure to be a cut in prices, and that makes the working man realize that there is no object for him to do as much as he can. I think if a man proves that he is efficient enough to double his work, let him do it, but it always makes trouble to cut prices, that means decreased efficiency. If you decide to pay a man eight cents for one particular mold and you estimate

that he should make 40 of them a day and he hustles and takes an interest in his work and is able to put up 70 molds a day, well isn't that making that much more for you and why should you cut him down? That is the trouble with most of the piece-work systems, the molders are jealous of the manufacturer and suspicious of him.

Report of the A. F. A. Representatives on the Conference Board on Training of Apprentices

During the past year, your Association became affiliated with the Conference Board on Training of Apprentices, which now is composed of:

The National Association of Manufacturers,
The National Founders' Association,
The National Metal Trades Association,
The National Machine Tool Builders' Association,
The United Typothetae and Franklin Clubs of America, and
The American Foundrymen's Association.

The members of these organizations employ, normally over 5,000,000 persons. The invitation to join this Conference Board was passed upon favorably by your executive committe, and the representatives of the American Foundrymen's Association on this board follow: R. A. Bull, president of the American Foundrymen's Association, Commonwealth Steel Co., Granite City, Ill., (ex-officio); Benj. D. Fuller, Westinghouse Electric & Mfg. Co., Cleveland, and F. M. Leavitt, University of Chicago, Chicago.

A meeting of this Conference Board was held at the Hotel Astor, New York, April 22, 1916, which was attended by delegates from each of these associations, your Society having been represented by Messrs. Fuller and Leavitt.

To defray the anticipated expenditures during the ensuing half-year, it was decided to levy an assessment of $100 on each co-operating association, but in view of the affiliation of the American Foundrymen's Association with the Conference Board on Feb. 17, it was decided that this assessment should not be levied against our organization.

The executive secretary of the Conference Board, M. W. Alexander, submitted a draft of a circular letter to be sent to all manufacturers, directing their attention to the necessity of instituting methods to train skilled workers systematically,

either by apprenticeships for boys and girls, or by specialized training for adults.

H. P. Porter, who represented the United Typothetae and Franklin Clubs of America, presented the manuscript of a paper on "Practical Apprenticeship", which since has been issued in the form of a bulletin.

The proposal now before Congress to enlist federal financial aid in the promotion of vocational education by various states, was discussed and many interesting arguments for and against the measure were presented. It was suggested that a federal subsidy would not only develop systems of vocational education, but also would have a tendency, under the provisions of the measure, to introduce uniformity in the various vocational systems. However, it was the sentiment of most of the members, that since the entire problem is still in the experimental stage, it would be advisable to permit the individual states to experiment with it a few years longer, in order to determine which solution would best meet the needs of the country and then only should an effort for uniformity be inaugurated. It also was claimed that the difference in industrial conditions, natural resources, and the status of general education, as between the northern and southern sections of the United States, as well as between various states of the union, was so great that uniformity of vocational educational systems throughout the United States would prove inadvisable and harmful. It was decided, therefore, that it was outside the province of the Conference Board to take any definite action.

Since the American Foundrymen's Association has been affiliated with the Conference Board, one bulletin, entitled "Practical Apprenticeship," has been mailed to the members, as well as a letter directing attention to the need of training skilled workers.

The Conference Board has issued an "Agreement of Apprenticeship" and a "Certificate of Apprenticeship" which will be furnished all of our members upon application.

Benj. D. Fuller, Chairman
Frank M. Leavitt
R. A. Bull

Discussion—Report of A. F. A. Representatives on Conference Board on Training of Apprentices

Mr. C. B. Connelley.—I feel that this is a very important subject. The government is soon going to take a hand in this and the technical and continuation schools are doing everything they can. The Corporation Schools' Committee met in convention not very long ago; they represent about three billion dollars and this was discussed by them. I feel just as sure that this thing will come and will solve the problems of the foundry, the cost systems, profit-sharing systems, etc. It must solve these things because it is the man higher up that needs the training as much as the apprentice. This morning you discussed both the cost and profit-sharing systems, but the way to really get at this is by training the apprentices. You can talk as you like about union, lack of soul in a large corporation and all that, but we must remember that this is industrial art, that it is purely an economic condition, and I am very sorry, being in educational work, that we did not have more of the program devoted to this and have representatives tell what the universities and schools are doing for apprentices. If we are to do anything in an educational line, we ought to have representation. I happen to be a member of this Association and I am doing a little work in a modest way in the educational line. I did not get to Atlantic City last year. I have been associated with you for some time and am interested in the continuation schools. This work is gradually being developed. Dr. Moldenke spoke of the pension system in Germany being taken over by the government. In this country the continuation schools will be promoted by the government and when a young man leaves school and goes to work, the laws of this country are going to force the manufacturer to send that young man back to school. And what does that mean? It means he will get the practical experience

in the shop and he is going back to the school to continue the academic work. This will do away with the necessity of being patronized when he comes down to pensions. Now, no red-blooded man wants a pension from the government, he doesn't want it from the manufacturer, he doesn't want any profit-sharing business unless he can simply put the punch behind it. The American people who are doing these things educationally are doing it for the benefit of humanity. The manufacturers do not get in touch with their men. I know what corporations are; I know the societies that are mentioned in this report. I am affiliated with four of them, and I know that the manufacturers themselves will not acquaint the other fellow with what they are doing, and in the name of common sense, how are we in the educational line to educate the apprentices when the manufacturer himself refuses to tell anything about his business, his profit-sharing, etc. Now, I have all the faith in the world in the education of apprentices in the public schools and also the technical schools. The United States government is going to pay for this. We changed the school code in Pennsylvania about four years ago, and the government and states will give this matter more attention every year. I would not have missed the meeting yesterday and today for anything. I wish there were more representatives of schools and colleges to speak to you here on this subject.

THE CHAIRMAN, R. A. BULL.—We are very glad indeed to hear from Dean Connelley, of the Carnegie Institute, which is doing so much effective work along these lines of industrial training.

DR. RICHARD MOLDENKE.—I am delighted to state that from our little village, this year we expect to send three young men to the Carnegie Institute.

MR. C. B. CONNELLEY.—I am very glad to hear that. I wish to state that in our school we do not produce anything but the boy. It is our job to try to do that. We want to get the men in educational work to deliver the goods just like the man in the foundry has to deliver it. Now, that must be done and we all realize that at the present we are hampered by economic conditions. We want the foundrymen to come and take part in the educational institutions of this country. We can

graduate a printer from our institution and put the Carnegie stamp on him and he might be able to get a job, but we want to graduate young men who are interested in their work and we are trying to do just that. You have spoken today of preparedness. In the near future commercial competition is going to be very keen. When this war is over, everybody will have to be in the best possible condition to compete successfully with others in his own line. We don't care anything about the manufacturers; we don't care anything about the corporation; we have the human element to deal with and we want to give it the very best possible, and I think it is your duty to see that the young people in your city are getting the best out of the schools. I happen to be a member of the Board of Education in Pittsburgh, and it is our duty to see that the schools are conducted in such a way that the children will be able to go forth and become useful and successful citizens. Look at the schools abroad, see the work they have done and the influence they have had upon the various nations. It has been said that we are an extravagant nation. Heaven knows we are, we don't know enough to save, but it is time we are learning; we must educate the children along this line. We must teach the child to save, and why not let him start at the very beginning? Everybody is ready for this change, all want it, it is just a matter of starting right. Don't be jealous of the other fellow, just put a little soul in your work and you will have no trouble.

Mr. B. D. Fuller.—I agree with everything that Prof. Connelley has said, I think we have to look in that direction for help in the future. I think that everybody is waking up to this. Here in Cleveland we have both the East and West Technical schools, both of which are overcrowded. I have come in contact with the gentlemen at the head of those two schools because of a certain line of work in connection with them, and in our little city west of Cleveland—Lakewood—we have just appropriated $400,000 for a building which will be devoted largely to technical work. I agree with Mr. Connelley thoroughly that this question is being actively agitated all over the country and that the one place we have got to look for the finished product is our technical school. They don't attempt

to turn out molders, but what the boy learns at the school is of advantage to him. I have had patternmakers from the Cleveland technical schools, three or four of them, and after finishing at these schools, they are far enough advanced to be in the third year class of apprentices; they are much better fitted than the ordinary boy who goes through the mill in the shop. Nobody wants to be a molder nowadays, but I hope it will be possible to knock into the boy the knowledge that there is something in the molding trade.

Mr. A. H. Kramer.—I believe we are deceiving ourselves very much in this matter; one of the principle reasons why we are not making apprentices is because we are stealing them from one another. I am only a small manufacturer, I employ about 80 men, but I find that after I have brought up the apprentices to where they are making a little money for me somebody else takes them from me. Now, that is the reason I don't care to make many of them. I am making as many as I consistently can, but somebody is getting the benefit of that and that is the reason we are not making apprentices, because we steal them from one another. We are not doing the right thing, we foundrymen, we should make a contract with the apprentices that they would have to stay in the factory where they start to learn their trade, or they cannot finish their trade in any other place. That is the way I had to do; I remained in the shop where I started. The question may arise that the man cannot make himself a full-fledged mechanic, nevertheless, if the manufacturer shows the right spirit, he can make him good enough so that he can go into almost any shop and do a day's work. Now, the technical schools cannot make a molder, not what I call a molder; they can make molding machine men, but they cannot make a full-fledged molder.

Mr. C. B. Connelley.—I think you have quite the wrong idea of a technical education. No technical school or training school ever tried to make a full-fledged apprentice. The technical schools try to make the boy realize what his work is to him, and best of all to appreciate the rights of the other fellow. That is what we try to have them learn, and the schools all over the country are forcing that on the young men. If nobody wants foundry work, it is the fault of the foundrymen them-

selves; they are too busy doing other things than to train the boys and make them appreciate what their work means. Mr. Kramer has said that foundrymen are not training apprentices because somebody will come along and steal them; if that is the case, I would like to tell Mr. Kramer it is because *he* is not training them right, because if he put the right incentive before the boy, nobody could steal him. The boy is worth no more money to anyone else than he is to you, and if he is worth any more to the other fellow, he is worth more to you, and you should pay him accordingly. We all have our problems and we should look at them squarely, but I think when it comes down to fine points, you will find it is all a lack of appreciation and inspiration. All of the boys the school turns out may not be the best kind of workmen, but we try to instill into them appreciation of their work, the proper spirit. We try to teach the young man that there is just as much in molding as there is in metal work or patternmaking or printing, or in painting a picture. I have been associated with young men for some time and I tell them that when they turn out a wonderful mold or casting it is just as noble a piece of work as the canvas which the artist has produced. Look at the wonderful castings that have been made in Germany during the past 25 years. Can you imagine anything more artistic? If a man can only put soul into his work, no matter what that work is, he will be a success.

Mr. A. H. Kramer.—With reference to the man who makes the apprentice being able to pay as much as the man who steals him, I will say that that is not true. When a boy comes into your shop he is of very little value; during the first year he is really not earning the wage you give him; the second year he is doing a little better, and the third year he is earning a little bit for you and that is when the other fellow steps in and takes him. You should receive the benefit for those first two years, the losses you sustain during that time.

Mr. Richard Bruce.—I have listened with considerable interest to the discussion by my friends, Mr. Connelley, and Mr. Kramer, but I agree with friend Kramer. You can take a boy into your foundry and for the first six months he probably does not earn his bread, unless he specializes in some line

of work, but if you put him on the floor for the first year, what do you get out of him? You get nothing. How many apprentices learn the trade—I don't mean the special job, I mean how many become all-around molders? I had to serve the full time when I learned my trade. If you learn a trade nowadays in one shop and you go to another, can you do the work? The trouble today is that the apprentices don't want to learn the trade itself, they want to specialize. In a great many shops, even the largest in the country, they take a boy in to teach him a trade, and they put him on a certain kind of work; he proves efficient on that job, and then I feel sorry for him because after that he will get no chance at anything else. I think you will all agree with me that a boy can go to a pattern shop in a stand-up collar; he goes home with that stand-up collar on and he can wear it while he is at work. It has often been said that a drop of patternmakers' sweat is worth $50.00. Now, I never bought any because I never saw any, but it is different when the boy has to go into the foundry, he has to work hard and go home looking dirty. We all love children, we all want the children to get the best things possible. I am not a man with a great deal of money, but I love my children as much as the man with money does, and a lot of men in Pittsburgh and other cities are keeping themselves poor by sending their children to the technical schools. After they have finished their four years' course, they have got all the technical schools can do for them. I say this with all due respect to the teachers in the schools and to Professor Connelley. Now, what are you going to do with them? They have had no practical experience in the school and the boy would much rather go into the pattern shop than into the foundry, because he can go there dressed up. You must treat the boys right and not steal them from each other. The Brother over here is right; you get a smart boy and he works well for you; after a little while somebody comes along and offers him half a dollar more, because he is a good, intelligent boy, and he goes there. You have no way of restraining that man from taking the boy from you. When I was learning my trade, the time was from four to seven years, and you could not go to another shop without your papers. They

made mechanics and molders in those days, but they are not making molders today, they are making specialists. We must all get together and decide not to take one another's apprentices and by so doing we will benefit ourselves. The Dean said, I believe, that molding was a pretty good trade. There are a good many men who have served their time—the old men—and you can take them into a foundry and they can make any part, big or little. How many can do that today that have served their time, that is, learned their trade during the last 15 years? It is said that the patternmaker must be a little better educated than the poor molder, the molder does not need the same amount of education. There are lots of men who cannot even sign their own names, who can make as fine a casting as was ever turned out; but they cannot read blue prints. Now, gentlemen, you have got to get your minds made up that if you want molders in this country you have got to teach them the work.

Mr. C. B. Connelley.—The gentleman has misunderstood what I said. I agree with him. I say no matter what kind of work a man is doing, it does not matter, it is what he makes of his work that counts, and what he makes of his children. Now, do you mean to tell me that the molder is not respected because his hands are dirty; and that he is not thought just as much of as a patternmaker? Do you mean to say that the machinist is more respected than the molder or the printer? The difficulty is this; as once was remarked, the patternmaker is a necessary evil, he is necessary to the work that is done in the foundry. Now, as to the all-around molder and the specialist, you all know that we haven't any more all-around mechanics. The technical schools try to pick out the man to fit a particular job; we haven't any more all-around men like my good friend Dick, you can't make them, he can't make them, and the schools can't make them. The technical schools in Cleveland—and I don't know of any finer ones in the world—are doing a wonderful work. Our school is well-known and there are splendid schools all over the country. The people who are directing these schools have their hearts in the right place, they are trying to pick the men for the jobs. Now, if you don't like the way the schools are run, you men, you

employers, get together and tell your respective school boards about it, and don't tell the children that the occupation of the molder is not a good one because he has to wear a dirty shirt. It is just as necessary as any other work, just as necessary as patternmaking, printing, etc. Don't say it is a dirty-shirt job, don't tell the children to take up another occupation because they can go there wearing a white collar; let us get away from all that. The man who has done a hard day's work feels better, after he has washed up, than anybody else, because, as I said before, it is what you make of your job, the soul that you put into it, that's the thing that counts.

Mr. G. von Rottweiler.—This is a very interesting subject. I received my education in Germany, where they made an engineer out of me. In Germany a boy leaves school at 14 and goes to a foundry, but he must attend the continuation school, the government compels him to, and in that continuation school they teach him the mechanical sciences of foundry practice. Now, how many molders have you today, who know anything about iron, who know anything about brass, who know what the thing does after it is poured? They don't know that, not very many of them do. Here is one thing we have got to do, we need apprentices and we have got to make them, but we have got to make apprentices that know the work from A to Z, and, therefore, they must have a technical education along these lines. You all know that the German molders are good molders, if you get hold of any of them you want to keep them. I am speaking of those who learned their trade in Germany. For the first four years of his apprenticeship the German molder does not receive a cent, but he learns his trade well and if you get him in your shop you never let him go, you will raise his wages because he is a good man. With reference to taking apprentices away from one another, they do not do that in Germany. The boy receives a certificate at the end of his four years, stating that he is able to make any kind of a casting, that is, go ahead and pour it; he is a full-fledged foundryman, a pourer of metal, and, I want to tell you that when that fellow gets through he is a molder, he is a coremaker and can work on the cupola, he can run it; but I want to tell you, we don't make those kind of

fellows in this country. After a fellow has worked in the foundry for a short time, he will leave and go to another foundry and say, "I am a molder, I want $2.75 a day," and the superintendent hires him, too. Now, you don't find anything like that in the old country. These conditions are all your own fault, you have to blame yourself, because you allow these things to continue. You should not take each other's apprentices. If a boy has to go to a continuation school, he can take up the technical part of his trade and he can make a man of himself, he can develop. The man who goes into this and makes apprentices, is going to cut down his losses, he is going to turn out castings. Germany has done these things and has done them well; I know they have made mistakes in lots of things, but you have got to give the devil his due.

The Chairman.—This has been a very interesting and helpful discussion. It is pertinent for me to say at this time that at the meeting of the Executive Board of this Association last Monday night, it was decided to continue our affiliations with the Conference Board on the Training of Apprentices for another year. As you can see in the report, it is necessary for the Association to pay $100.00 a year, and, of course, the traveling expenses of our representatives.

Mr. A. H. Kramer.—Is this discussion on apprentices closed?

The Chairman.—Not at all. I think that interest has been awakened and this is a subject that will be carried over.

Mr. A. H. Kramer.—Well, I don't think we have really made a fair start on the proposition. I believe a committee should be appointed at this session to draft some form of contract to be submitted to each and every apprentice in all foundries.

The Chairman.—Wouldn't it be appropriate, Mr. Kramer, for the Association to submit to its representatives to the Conference—the three members of the Association who are naturally closely tied up with this whole proposition—the preparation of that, to submit this to the Board of the Association for whatever action it deems necessary?

Mr. A. H. Kramer.—Yes, that would be all right, but don't drop it. This has been going on for years, so let's have something come of it.

The Chairman.—Would you like to make a motion to that effect?

Mr. A. H. Kramer.—Yes, but I will leave the wording of it to you.

The Chairman.—I might state that the question, as I understand it, is to be submitted for adoption, is as follows: "That the representatives of this Association, the three men who represent this Association on the Conference Board, are to be empowered to draft apprentice regulations and to submit them to the Board of this Association for whatever action the Board deems necessary to take."

Motion Seconded and Adopted

Mr. Wilson.—I would like to find out if the different members of this Association are making any efforts to train molders. I expected this would be brought up in the present discussion, but it has not been touched upon. We are particularly interested in that phase of the subject; as you all know, at present we need more molders; molders are hard to get, otherwise employers would not be stealing them from each other, as Mr. Kramer said. We need molders and we need them right away and we are interested to know of the efforts the different members are making to train them rapidly. In our plant we have attempted to carry on some educational work along with the practical work; we are teaching the apprentices arithmetic such as they would get in high school, advanced algebra, mechanical drawing, etc.; we have regular classes for them outside of shop hours, but we have not gone far enough in the work to know whether we are throwing money away or not. I would be very much interested to find out what steps other foundries are taking along this line. As I said, we need molders, we need them now, and we want to know how men can be trained to do the work in the shortest possible time.

Mr. G. E. Jones.—I investigated the Crane system, and at one time had the privilege of instructing some of the elementary classes in mechanical drawing. This company provided a night

school in their factory; they would take the men in there and show them how to do the work, how to pour the castings, etc., explaining the thing to them as they went along. I can say they are getting some very good results from some of the green help. Very often, boys would be brought in who could not read nor write, and they would be taught in this night school, instructed in mechanical drawing and machine work. I don't know whether they have gotten into the molding question very extensively or not, but if Mr. Smith is here he might be able to tell you something further about this work.

Mr. C. B. Connelley.—Some corporations instead of conducting night schools are taking the apprentices during the day and teaching them. I have not heard, however, that they are making a specialty of molding. If you will send to the General Electric Co., New York City, you will be sent the proceedings of the convention and it will tell you just what they are doing. They are spending hundreds of thousands of dollars in training apprentices. Their apprentices are indentured, as Mr. Kramer has suggested, but they are indentured from the manufacturer's point, not from the point of co-operation between the two. Now, all of this is not realized, gentlemen, as yet, just because we have not been able to get up to it, but you can get the information on the work of the corporation schools. The last convention of the National Association of Corporation Schools was held at the Carnegie Institute of Technology, Pittsburgh, in May, 1916.

Mr. Wilson.—I brought up this subject to find out what work is being done to make molders. You can make blacksmiths, machine men, etc., but it is hard to make molders. I thought at such a convention as this, where there are so many foundrymen represented, that I could get some ideas as to how the work is being carried on.

Mr. J. P. Pero.—I think that we of the foundry trade have sowed the wind and are reaping the whirlwind. A generation or two ago the boys were indentured as apprentices and they were taught the foundry business. I know I was indentured and I was taught coremaking and later, molding, and the boys in those days were really taught to be molders, but in these times, due to changing conditions, we have given up making

molders; we are making specialists, and I think that this has been due largely to the cupidity of the manufacturers and the attitude of the labor unions, as well as the existing conditions. We are feeling it today in our business in consequence of not having made these molders and we are not looking at the future at all. We gentlemen who are kicking today are not looking out for future generations. We don't care what is going to happen to our sons and grandsons. Now, I have to plead guilty with the rest; it is a fact that when we take a boy in our foundry and find out where he can make the most money, we make him stick to that particular job, and that is the reason for the small percentage of men employed in foundries today who are all-around molders. We have specialized too much; we have things down so fine that there are very few shops where a man can be trained to be an all-around molder. I think it is going to be absolutely necessary for us in the foundry business to take some action on this apprenticeship business. I don't know that we are going to need them in the rank and file, but there are a great many technical men today who know practically nothing about molding. Things are not as they should be, as we all know. This apprenticeship question is a great big subject and I am glad it is going to be continued.

Mr. Stanley G. Flagg III.—In looking around the shops today, you will find practically no molders, they are all specialists; they can operate a certain type of molding machine, etc., but you do not find the all-around molder. The foreman should take the boy and teach him to do the various things around the foundry. We know that some of them amount to practically nothing, but we should take those boys and put them through and try to develop them, and in this way we can make them first-class assistant foremen, core bosses or gang bosses; we should train the boys to be foremen. We are advertising more and more in the papers for men; we do not get experienced men; we have to take what we can get; a great many men do not care to work in the foundry today because it is hard work, because there is a certain element that they do not care to associate with; the work does not appeal to the average American boy, but we should take the boys and educate them ourselves and show them the advantages of this vocation.

Mr. Wilson.—I don't like to talk so much, or so often, but I am very anxious to find out what the other fellows are doing; I am trying to tell you what we are doing and I want to know what your experience is. Along the line of what the last gentleman has said, we are glad to get boys that can be trained to be assistant foremen, but usually you put a boy on a certain class of work until he is familiar with that, then you put him in the pattern shop, the machine shop and give him some of that work, in an effort to develop him, but not all are able to succeed in the various lines. The development of foremen is really not the point I am talking about. I want to know what the firms are doing in an educational way, as I want to know if I am warranted in carrying on this work. Of course, I think that a molder and foundryman should know something about patternmaking, etc., and that is what we are endeavoring to teach them. I would like to have some of your experiences.

Mr. G. von Rottweiler.—Mr. Wilson just mentioned that the molder or foundryman should know something about patternmaking and machine shop practice. However, I do not agree with this. Yesterday morning we had a meeting and we talked about the co-operation of the engineer with the foundryman. If a pattern comes into the foundry it should be workable and if any controversy comes up between the machine shop and the foundry it is blamed on the pattern by one and on the casting by the other; but that has got nothing to do with the foundry; in other words, with the molder except the superintendent, who is supposed to know a little more than the workingman. We must develop nothing else but a foundryman who knows how to make a simple casting, to make the casting quickly and cheaply. In the next five years we will see that foundry practice will be entirely different to what it has been in the last 10 years. Everybody is trying to make machinery that will do molding, machines that will turn out cores. I have not seen any yet, but it will certainly come, and we will need men who will be able to operate those machines. Very soon somebody on the other end of the pond is going to do it, but it is up to us to do it first; we need men who will be able to do these things and these men must

be technically trained. We won't need hand molders within 10 years, because it will all be done by machinery, so I think it would be a good thing for the Committee that works along these lines to investigate in detail what is going on in other parts of the world, not only in this country, but in Europe, and to see what the other fellows are doing. This is the situation; this country makes 1,000 pieces where Germany makes 100, and we can find a market for those 1,000 pieces right here and Germany has to go all over the world to get rid of the 100. We are going to require a whole lot of expensive machinery to do the work, but so will Germany and they can't afford to get that machinery and make a whole lot of castings if they haven't the market. We have got to make the men to meet this contingency, but we are not making them; therefore, I think that that Committee ought to investigate those details. I think the Committee should take that up and go into it very deeply and we will all benefit.

Mr. A. H. Kramer.—I just want to ask if anybody here knows what salaries are being paid to the teachers in the technical schools, particularly the foundry departments. I would like to know the salaries in the various cities.

Mr. C. B. Connelley.—Two thousand dollars per year.

A Member.—In St. Louis it is $1,800.00.

Mr. A. H. Kramer.—Those salaries are exceptional; I believe the majority will rank between $800.00 and $1,500.00. What kind of a man are you going to get for such a salary to teach practical work? I think we should see that the appointments are given to the men who are best fitted for this kind of work. I know in one city in Ohio we have a man in the foundry department in the technical school who is not capable of teaching a young man to read a blue print.

Mr. C. B. Connelley.—Mr. Kramer, there is no profession where you can "throw such a bluff" as the teaching profession, but I want to tell you it is your fault as much as my fault, it is the fault of everybody who pays taxes.

Mr. A. H. Kramer.—I want to say just this and then I'm through. I want to say this without any fear of contradiction. I signed the application of a thoroughly practical man in the

city in which I live and I got a number of other foundrymen to do so, but he was turned down.

Mr. C. B. Connelley.—Well, other people have had the very same experience. I have had the same experience in our school where an effort was made to put a man who had a degree in the place of a practical man and I have had to fight, and when I said it was your fault, I did not mean anything personal, I mean it is the fault of every taxpayer. Why, bless you heart, it is the fault of everyone, why don't we have better government? It is our fault. We have got to start at the bottom of this thing; we had to in the public schools and we will have to in the technical schools, and it is well-known that the public schools are none too good, but the people do not take enough interest; it is their own fault. It is much the same with the churches and other institutions to which we give our money for their up-keep; you will say about the churches, "Oh, let the wife take care of that, I haven't the time." We don't take the proper interest in things that's all. The teachers are really doing more at the present time than they have ever done before.

The Chairman.—I am going to request that the members compile, if possible, the data Mr. Wilson desires, that is, the members of that Committee. I'm afraid we will have to discontinue this discussion and I am sorry because this is a serious matter, but it is growing late.

Mr. Wilson.—Before we leave this subject I would like to make a motion that the Committee be requested to gather data from the various foundries as to what each one is doing to educate its apprentices.

The Chairman.—It has been moved and seconded that a Committee be appointed by the chair to compile information with reference to suitable apprenticeship articles, indentures, and that the information resulting therefrom be sent to each member of the Association. I think that motion should be worked out so as to make it conditional that it must have the sanction of the board of directors. I think that should be incorporated. Mr. Wilson, are you satisfied with the motion as stated by the Chair?

Upon consent of Mr. Wilson, the motion as set forth was carried.

Foundry Work at the University of Nebraska

By John Grennan, Lincoln, Neb.

A certain paper presented before the American Foundrymen's Association at its last annual meeting and published in the Society's transactions is apt to give some exaggerated ideas as to what can be accomplished in a few weeks in a university foundry. This paper described the course presented in the foundry at the University of Illinois. By comparing their catalog with the catalog of the University of Nebraska, it was found that the foundry courses in the two schools were given under similar conditions. All freshmen engineers are supposed to take the courses. The course at the University of Nebraska has been developed until it seems to be about all the average freshman student can handle, but it is much simpler than had been planned.

In presenting foundry work in a university, the reason for the course in the schedule should be one of the first things considered. At different schools this reason seems to vary. In some schools it is given in the freshman year and to all engineers. In other schools foundry work is given to mechanical engineering students only and in the latter part of the course; usually the junior or senior year. More commonly the work is given in the freshman year to all engineering students.

Freshmen Lack Skill

Under ordinary conditions the freshman student in a university is about 18 years of age and has done nothing but go to school. In a college course for engineers the first year is usually a general preparation for the work to follow and in a great many schools the students are not classified in any branch of engineering. Any course in the freshman year should be designed to meet this general condition. One of the striking characteristics of the freshman student is his inability to handle

Since writing this paper, the author has learned that the foundry course at the University of Illinois has been reorganized and this work is now given in the second year instead of the first.

tools and make measurements or to take the necessary time to go through all the details required for a skilled piece of work.

Were one to stop and consider general foundry work, it will be seen to be well adapted for a freshman course where a general shop knowledge is desired. The nature of foundry work is such that it can easily be graded from simple molds that any intelligent person could be taught to make in a few moments, to complicated ones that require considerable skill. Added to this, there is the coremaking that can be made easy or hard, as desired, the spectacular work of handling molten iron and the cleaning of the castings. It is all very interesting and by the time a student has made cores and molds, helped about the cupola, cast his molds and helped to clean castings, he has had a more general experience than he could get in almost any other shop. This experience, in addition to the benefit received in designing, is, I believe, the reason why foundry work is usually given to the freshman engineer.

At the University of Nebraska the foundry work is given in the second semester of the freshman year, all engineers being required to take it. The class is divided into four sections, each section working two periods of four hours each a week, for eight weeks. The four sections meet together once a week for a one-hour lecture. This makes nine hours a week for eight weeks, or 72 hours. In some schools the time spent in the foundry is more than this and in some less, but this is a fair average. The usual method is to give a combined course with patternmaking, giving two periods a week for a semester, the time being divided in different ways between the two shops.

Boiling Down is Necessary

To present as large a subject as foundry work in 72 hours must necessarily require a great deal of boiling down, and there are several things to be avoided. If too much ground is covered, there is danger that little will be retained by the student. Too much demonstrating may lead the students to imitate the exact motions of the instructor. Another danger is that in individual instruction the instructor may actually make the piece and the work will be like a child's writing

where the teacher takes the hand of the pupil and all he does is to hold the pen.

The first four hours in the foundry are spent in the core-room. A mold is rammed up by the instructor, in which the cores to be made are set. After the nature of the different sands and binders is explained, a batch of sand is mixed up and the making of cores is demonstrated. The cores consist of two straight round cores and a stop-off core. One of the

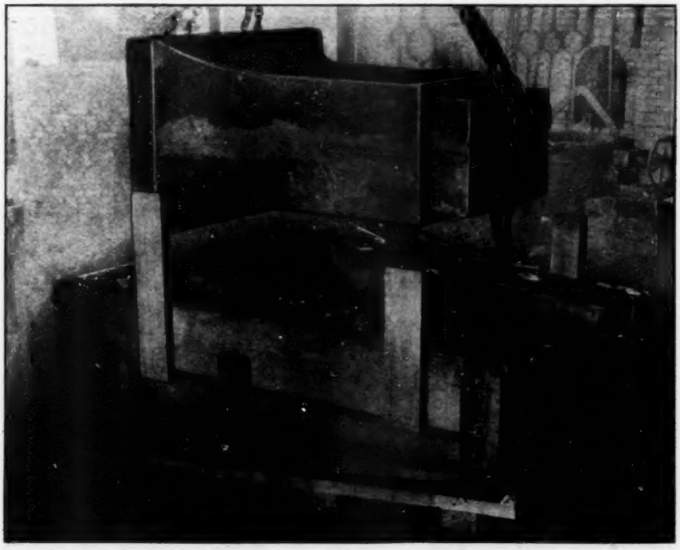


FIG. 1—SETTING A CORE IN A LARGE MOLD

straight cores is made in halves and pasted; the other is made whole and rolled out on a plate. Usually the time taken to demonstrate the mold and the cores leaves the students very little time to work the first period. By the time they make dry and paste these cores, and make enough extra to allow for breakage, the period is over.

The second period is put in in the foundry. The first mold made consists of a flat back with four patterns in the flask. The patterns show the use of four different cores. One is a

green sand core and the other three show methods of coring vertical and horizontal holes, one being below the parting, where the stop-off core is used. A 15-inch square flask is used and the work is done on the floor, nearly all the molding being floor work.

Work is not Cut and Dried

The first exercise is the only one on which all the students work at the same time and is the only one demonstrated com-

FIG. 2—POURING THE MOLD SHOWN IN FIG. 1

pletely. A text book is used and individual instruction given when necessary on the other exercises. The course is not a cut and dried one, but as much is given as the student can assimilate.

The second exercise may be one of several, the choice usually favoring a 12-inch, three-blade propeller, which teaches the making of irregular parting lines. As most of the small flasks used in the shop are made of cast iron, several sizes and depths of flask patterns are used. These teach the ram-

ming of deeper molds and the ramming of cores in a mold to make the handles. Lugs also are cast on the flask by the use of a loose piece and cover-core. A core pulley with the inside coped-out is used to teach the use of soldiers in securing the sand in the mold. This pulley has a flange on the bottom

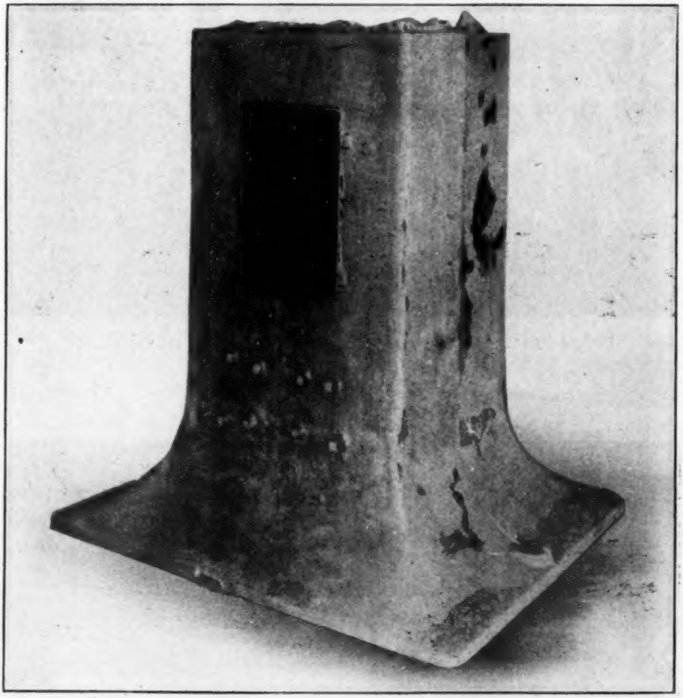


FIG. 3—THE CASTING TAKEN FROM THE MOLD SHOWN IN FIG. 1

that makes a three-part flask necessary. A 3-inch and a 5-inch elbow are used to teach the setting of chaplets. There is considerable demand for castings for exercises in the machine shop. Among these exercises is a two-horsepower gasoline engine. The machine shop exercises, with the other work wanted in other departments, create a demand for castings that have to stand the test of being used. This work makes

FIG. 4—A GROUP OF CASTINGS IN THE MACHINE SHOP

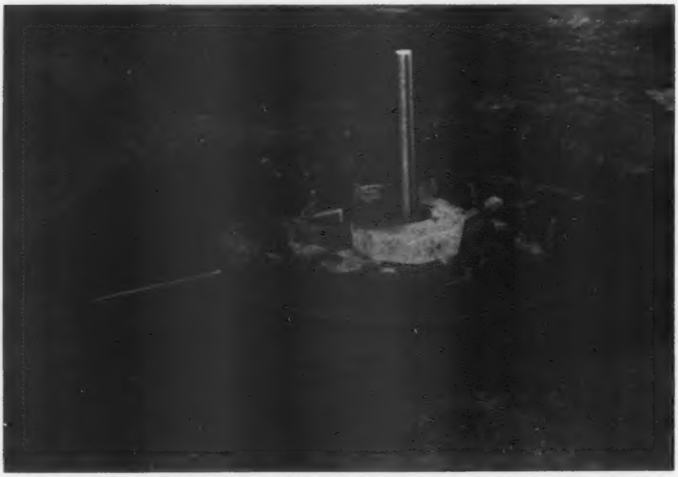


FIG. 5—A WHEEL WITH HUB, ARMS AND SEGMENT OF RIM

it possible to run the foundry like a jobbing shop for two or three weeks. During this time students are put in the core room to make cores. Very few can learn to make jacket cores that stand the test of being used in a mold. In the heavier work a wheel is made with cored arms and hub and a segment of the rim. This wheel is usually made in the floor. A cylinder head is swept-up to show the use of sweeps. This cylinder head is made in dry sand as are heavy pieces for the machine shop.

Since all the work in the foundry is done by the students, heats usually are run off about once a week, the weight running from one to two tons. All the molds that are passed by the instructor are cast. The students clean out and daub-up the cupola, put in the bottom, weigh out the coke and iron and do the charging. There is no difficulty in running the cupola with students. The only work not done by students is the tapping. As no class casts more than twice, the janitor does the tapping and this leaves the instructor free to devote all his time to the pouring and avoid possible accidents. In the last five years no one has been burned. After casting, the flasks are shaken-out and piled up. The casting and shaking-out takes a four-hour period. In the next period the castings are cleaned, inspected, sorted and weighed. All scrap is checked back to see how much iron was taken out of the cupola in comparison with that put in.

Non-Ferrous Metals are Cast

Besides the work done in cast iron, some copper and aluminum alloys are cast. On account of the lack of time and the cost of material only a few of the better students are put on this work, but every class has it explained and sees the crucibles pulled from the furnace and the molds poured.

In the lectures, the time is taken up mostly by descriptions of the cupola and other furnaces for melting brass and iron, and the metallurgy of metals used in the foundry. Dry sand and loam molding as well as molding machines are taken up. A time clock is used to check-up the students. The exercises are made on a time schedule or piece work rating. The students are graded on the amount and quality of their work. After

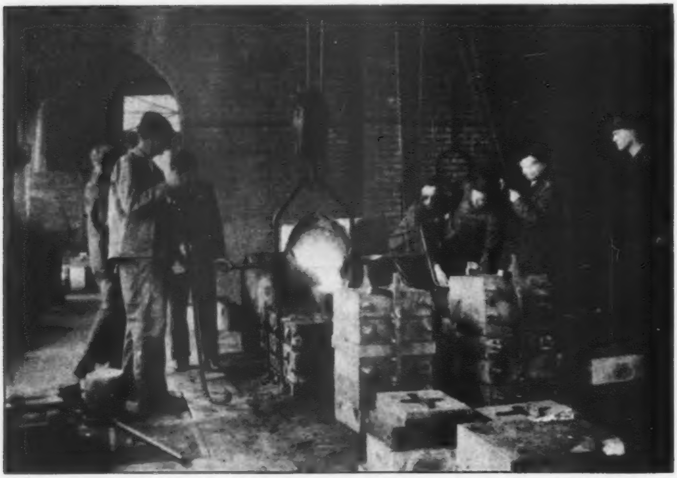


FIG. 6—STUDENTS POURING A MOLD

FIG. 7—MOLDS ON THE FLOOR READY FOR POURING BY STUDENTS

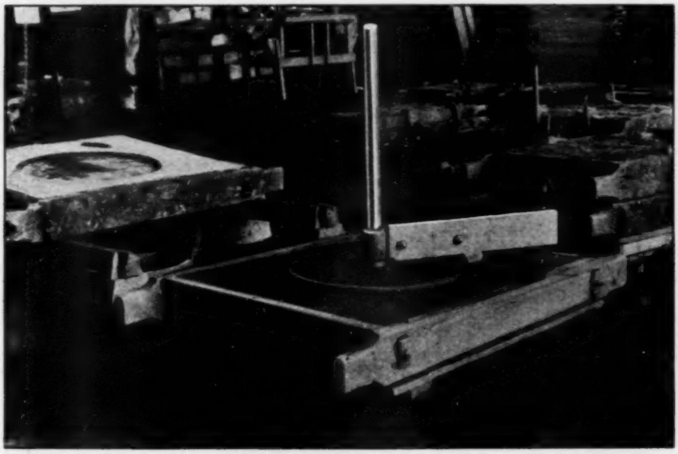


FIG. 8—A SWEEP JOB

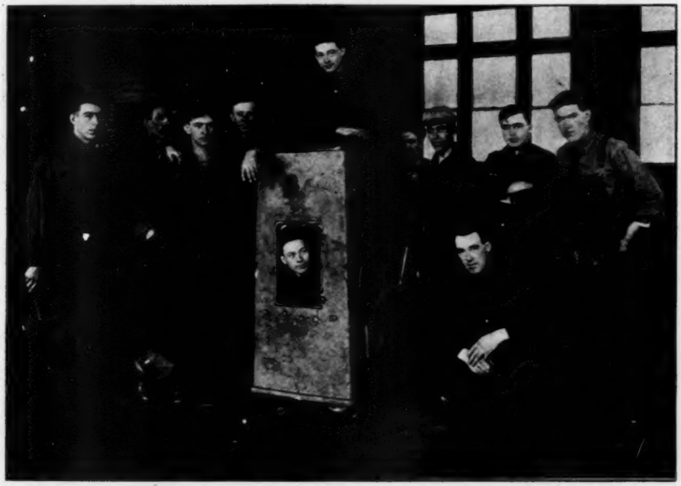


FIG. 9—A CLASS IN FOUNDRY PRACTICE

the students have finished the course, they are not foundrymen. What they have learned is not remarkable, but it is remarkable that they have learned anything. Very few students can come into the foundry after taking the course and on their own resources make good castings. The do know considerable about how to proceed in getting a pattern into the sand and out again and can see the reason for simplicity in the design of castings.

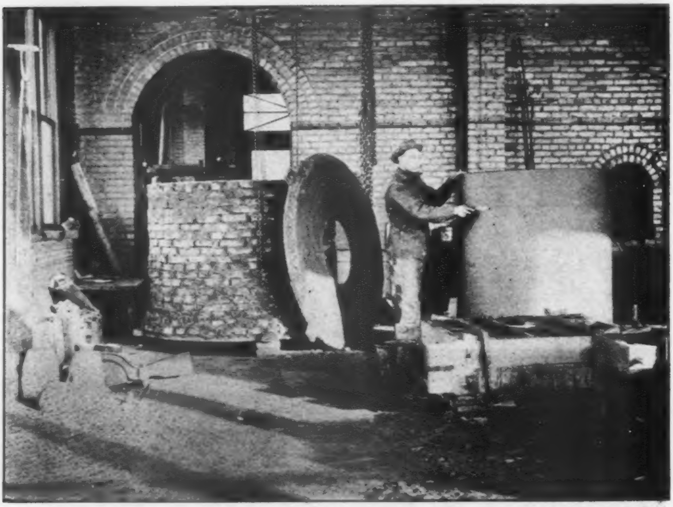


FIG. 10—A LOAM MOLD THAT WAS ELIMINATED FROM THE COURSE

Many Tempting Problems

There are a great many new and attractive things that a foundry instructor is tempted to try out. A molding machine suggests an idea like this: Take one of the exercises, the 12-inch propeller referred to above, and make it in as many ways as can be thought of, timing the different ways to determine which is the most profitable with a given number ordered. If one is wanted, no match would be used. If a few are wanted, a green sand match would be in order; for a few more, an oil match or a plaster of Paris match is tried. For

large orders, an aluminum match plate or a mounting on a molding machine is adopted. Just where would it be advisable to use one method or the other? This idea was tried out, but the time required to carry it through made it of little benefit to the students. Students have been tried out in different ways in the planning and directing of work for other students. In making cores for the gas engine cylinder a student was put in charge of three others working with five core boxes to keep the cores made in sets, and see that they were blacked, pasted and stored properly. Where two or more students worked together, one was appointed to direct the work. Students have inspected castings. In every case the student's experience was so limited that he had no initiative and could only repeat what he remembered from the directions given him by the instructor. Every year there is a desire to make improvements and introduce something new. The instructor feels that he has so simplified his ideas that the students cannot fail to grasp them, but as soon as he tries his new ideas he finds that his time must all be spent on laying a foundation. The time is far too short to do even this in a satisfactory way.

Foundrymen can expect little from universities in the development of skilled foundrymen until the universities recognize the difficulties encountered. Agricultural, architecural, highway, sanitary, municipal and a great many other engineering subjects are presented in engineering schools. Why not foundry engineering? The Wentworth Institute of Boston gives a course that is described in the *Iron Age,* Jan. 6, 1916. This course is the kind that will produce results that will be of use to foundrymen.

Analyzing Foundry Operations as a Basis for Improvement in Shop Conditions

By R. E. Kennedy, Urbana, Ill.

There is an old adage which says, "A new broom sweeps clean," and we always expect a man who enters a new position to make a strenuous effort to show results. When we hear some of the seemingly wonderful tales of how practicing engineers have gone into plants which were not paying or barely getting along and have made them pay good dividends, most of us are apt to credit such results to the theory expressed in the old saying. But to those who know, it is conceded that the reasons why such results can be accomplished by outsiders, admittedly not so familiar with details as the local management, are several. Not the least of them is the effect of a broad perspective unhampered by time honored traditions and methods. The fresh viewpoint of the practicing engineer gained through contact with many similar problems supplants what may have become restricted conceptions on the part of the local management.

Methods, policies and traditions are examined with unemotional care and the results of their operation shown in cold dollars and cents. If they do not produce the predicted results, they are supplanted by those that will. The process is one of elimination and constructive rebuilding. In the end only the efficient survives.

Obtaining the Right Viewpoint

Not all of the old methods are bad—on the contrary, many are very effective. The consulting expert does not sweep them all away, but rebuilds a new structure on the old foundation. The local organization can do the same thing if it knows how —and it should know how if it is composed of men of the right caliber. Daily contact with the grinding details that beset

every foundry operator makes it difficult for him to see beyond these details. If he does not take care, he will be looking at his business through the wrong end of the telescope. Then the small things become unduly important and the larger questions of policy may escape notice altogether.

The successful foundry operator knows that efficiency begins at the top and works down—that efficiency in the shop is the result of efficiency in the office. He knows that the best materials, the most effective methods and an organization of skillful workmen do not "just happen". On the contrary, he realizes with the keenest appreciation that these things follow only upon the dictation of the directing forces.

Factors in Analysis

Foundry operation, like practically all manufacturing, is a problem involving three factors, namely, labor, material and equipment. Each of these factors presents its own special problems, but as they are distinct in character, control is accomplished in a simple manner by dividing responsibility among members of the supervisory staff according to fitness and experience. No one man can be an expert in all lines and it is not good practice to shoulder upon one man a large variety of duties that he is not fitted to carry. Modern organization calls for specialists—each supreme in his own special field. Such a plan centralizes responsibility in the hands of thoroughly competent men who reduce costs by eliminating waste.

A critical examination of the principal operating factors should be the daily program of the foundry manager. A few hints as to the direction which this examination should take are indicated hereafter. We will take up a discussion of each of the three factors in the order of what we consider to be their importance. Labor is considered to be the most important because without the right kind of labor and its proper supervision, good material and equipment would go for naught.

Labor

You will often see two factories, situated almost side by side, manufacturing the same line of goods, with the same kind of equipment—yet the quality of the work will be vastly

different. This difference will almost invariably be traced to workmen, but the blame will have to be placed on the foremen or superintendents, for the workmen will produce the quality of output demanded of them or, if they do not, the right executives will either train their men to do better work or eliminate them and get others who will.

B2 4

FORM 102

INSTRUCTION CARD

SHOP LABORATORIES

FOUNDRY DEPARTMENT

PART *FACING MIXTURE N°8*

ARTICLE PATT. NO.

FLOOR BENCH MACHINE STATION 3

STANDARD FLASK NO.
SPECIAL FLASK NO.
CORE BOX NO. CORE PLATE NO.
SAND MIXTURE NO.
WIRE SIZE RODS, SIZE
NO. LOOSE PCS. NO. CORES

TOOL KIT NO.
RAMMER
FACING MIXT. NO.
TOOLS N°2 Shovel [illegible] Wheelbarrow N°8 2' Riddle

ITEM	OPERATION ROUTINE	STANDARD TIME
	NOTE. CARD MADE FOR EIGHT (8) WHEELBARROW LOADS. IF A LARGER BATCH IS NEEDED, USE QUANTITIES OF MATERIALS IN SAME PROPORTION.	
1.	FROM SAND BIN NO. 2 OBTAIN THREE (3) WHEELBARROW LOADS OF SAND AND TAKE TO MACHINE NO.-(4). DUMP INTO MIXING BOX..........................	.10
2.	FROM SAND BIN NO. 5 OBTAIN FIVE (5) LOADS OF SAND. TAKE TO MACHINE NO. (4). DUMP INTO MIXING BOX..	.20
3.	FROM STORAGE ROOM NO. (2), BIN NO. (3), OBTAIN ONE LOAD OF SEA COAL. TAKE TO MACHINE AND DUMP INTO MIXING BOX................................	.05
4.	MIX SAND AND COAL BY CUTTING THROUGH PILE WITH SHOVEL ONCE............	.05
5.	ADD TWO (2) BUCKETS OF WATER AND RUN THROUGH MIXER....................	.15
6.	SHOVEL INTO SAND BIN NO. (1)...	.08
	TOTAL STANDARD TIME	.63

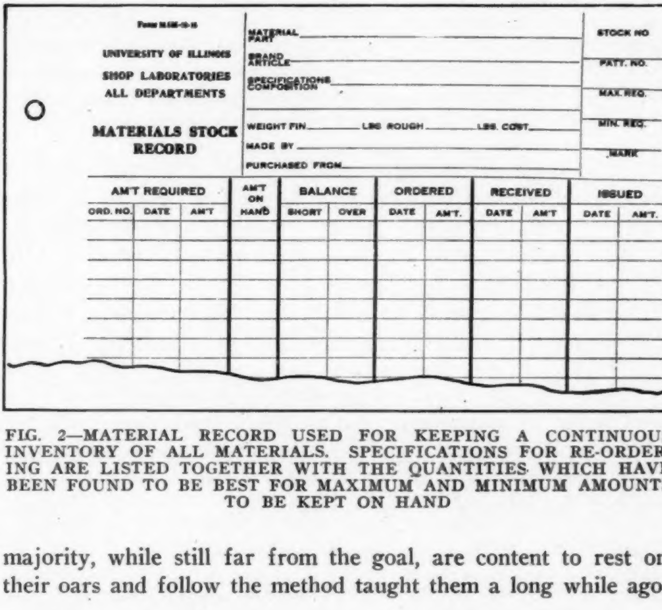
FIG. 1—INSTRUCTION CARD FOR THE GUIDANCE OF UNSKILLED LABOR, MAKING POSSIBLE ACCURATE RESULTS ALL THE TIME. VERBAL DIRECTIONS ARE ALWAYS LIABLE TO BE MISUNDERSTOOD OR ELSE NOT FOLLOWED DIRECTLY WHICH MEANS RESULTS THAT ARE FAR FROM PERFECT. CORE SAND MIXTURES, FACING MIXTURES AND ALL SIMILAR FOUNDRY COMPOUNDS CAN BE STANDARDIZED AND THESE STANDARDS KEPT ON INSTRUCTION CARDS FOR GUIDANCE IN MIXING

Where slipshod work is tolerated, there you will find a tendency for all the workmen to turn out slipshod work and when the best is demanded, you are sure to find the best. The whole question then of quality of output rests practically altogether with the management.

It behooves the management, therefore, to be strict in its demands and always on the lookout for ways and means of

keeping the quality and quantity of the product as near perfection as it is possible to go. The maintenance of labor standards means a constant study of men and their methods of doing the work they have been given to do.

It is well known that there are many ways of doing any one piece of work, but many forget that there is only one best way and no one has yet put into practice that best way. A few seem to have reached this best way, but the greater


UNIVERSITY OF ILLINOIS
SHOP LABORATORIES
ALL DEPARTMENTS

MATERIALS STOCK RECORD

MATERIAL / PART
BRAND / ARTICLE
SPECIFICATIONS / COMPOSITION
WEIGHT FIN. LBS ROUGH LBS. COST
MADE BY
PURCHASED FROM

STOCK NO.
PATT. NO.
MAX. REQ.
MIN. REQ.
MARK

AM'T REQUIRED			AM'T ON HAND	BALANCE		ORDERED		RECEIVED		ISSUED	
ORD. NO.	DATE	AM'T		SHORT	OVER	DATE	AM'T.	DATE	AM'T	DATE	AM'T.

FIG. 2—MATERIAL RECORD USED FOR KEEPING A CONTINUOUS INVENTORY OF ALL MATERIALS. SPECIFICATIONS FOR RE-ORDERING ARE LISTED TOGETHER WITH THE QUANTITIES WHICH HAVE BEEN FOUND TO BE BEST FOR MAXIMUM AND MINIMUM AMOUNTS TO BE KEPT ON HAND

majority, while still far from the goal, are content to rest on their oars and follow the method taught them a long while ago.

Value of Time and Motion Study in Hastening Changes

In foundry work there is no general way of determining whether the method in use is the best, and the common thing to do is to put a man on the job and let him go to it, the amount of advice given him being very small compared with the amount of valuable instruction which could be given.

The changing of methods is, as a general rule, a slow process of evolution, the changes being suggested from time to

time by certain circumstances brought to light mostly by chance. During recent years, due to the change of work and competition, it has been necessary for many shops to make thorough analyses of their operations to hasten improvements in methods and equipment. For these analyses, time and motion studies of the different classes of work have been made and it has been found that such a study, scientifically conducted, shows up the following factors:

1.—The improvement that can be made by the management in the conditions, equipment, and shop organization, to help the operator improve the quality and increase the output of his work.

2.—The work done by the operator which is unnecessary and by eliminating which the operator can turn out more product of as good a quality in the given time, without any more exertion.

Time study, when rightly applied, means the hastening of these changes because of the facts brought to light by scientific study of the conditions. These studies should be made by someone familiar with the local shop methods, familiar with the best practices in this line of work in other shops and one who will not let himself be held to the traditional shop method just because it had been customary to do the work in one certain way in the past.

Also, changes must not be made just because they have been made in other shops, but a careful detailed analysis of all the work being performed in the shop must be made and after thorough study of the probable results it is determined whether the changes will benefit the shop.

The Importance of Materials

In considering the materials used, the foundryman will first have to investigate his needs thoroughly. The question will have to be asked concerning each material item, "What is the real need in this case?" It might be possible to entirely eliminate the blacking of cores in certain cases if the sand were changed. Is the molding sand used giving as good results as that used by the most successful foundries in this line of work? Perhaps the castings would be selling better if a sand giving a smoother surface were used. Very often, the core sand in question is being used because it has been customary to use

it in past days and no one has suggested a change, or perhaps it is a cheap local sand and the foundryman hesitates about paying more for a sand from a distance. In one large Wisconsin foundry, the core-room foreman found that he was enabled to entirely eliminate the use of core dryers by using a different sand from that which had been used in the past.

Are the binders used really the best for the purpose of the shop or quality of casting to be produced? The use of an oil binder with an open sand frequently will do away with all venting The writer remembers a particularly striking example of unnecessary venting which was due to lack of knowledge. In a foundry, supposedly up to date, a binder was being used on certain waterjacket cores which made it necessary for the coremaker to spend 20 minutes venting each set of cores. The binder was changed to an oil compound and quartz sand mixtures which, though slightly more expensive, saved more than twice the entire expense of the binder by eliminating the venting. At the present time, many coremakers are spending needless time venting certain oil cores because no one in the foundry has taken the trouble to ascertain whether the venting can be done away with.

In other cases, a different sand and binder frequently does away with the use of dryers or will give more perfectly shaped cores. The best foundry practice is to use just enough core binder to hold the core sand together until the casting has set. If too much is used, the hard core requires extra work to remove it from the mold, therefore, the proper mixtures for different sized castings and kinds of metal should be determined. The shops which do not have their sand mixtures standardized are the most frequent loosers because of excessive binder.

The lack of enough binder and the subsequent loss of cores in handling is also due to failure to standardize the mixture. Using the best binder and sand, mixing them in the same way each time and baking them under the same conditions will produce the results wanted. Core sand and facing mixture standards are placed on cards, as shown in Fig. 1.

In the case of cupola supplies, it is a question of obtaining cupola blocks and clays of the best quality, for here, as in

nearly all other cases connected with the purchase of materials, it is a paying proposition to get the best. The money saved by the use of inferior, cheap grades will be more than offset by the expenditure of money caused by the amount of extra labor used in relining the cupola at more frequent intervals.

Material Records

Some form, such as the material record shown in Fig. 2, can be used not only for keeping track of the amount of material on hand, but has a place for the entry of a specification for the buying. With this specification, made out according to the best information obtainable, the materials should give satisfaction. The writer has found it to be common foundry practice to order minor foundry materials without any specification as to quality, which is as bad as a similar practice of ordering pig iron without specifying the chemical content.

Molding sand is another material to which a lot of thought should be given. Many are the foundries purchasing the same kind of sand from year to year without really knowing whether it is the best and cheaper when everything is considered.

It is very desirable that foundrymen keep a record of the weight of castings produced for each ton of sand used. Are many castings being lost by scabbing which would not occur by the use of a different sand? We all acknowledge that the best of molders can produce castings using any old sand, but does not the less skilled molder or machine hand have more trouble with scabbed castings? Changing the molding sand has often reduced the loss of scabbed castings, turned out by semi-skilled molders, to a minimum. It takes only a few bad castings to make some apparently cheap sands very dear in cost.

The necessity for giving strict attention to the purchase of materials cannot be given too much emphasis, for materials that require extreme care in handling will require very skilled men in their manipulation and skilled labor costs more than unskilled. We do not think anyone will advocate the use of this kind of material when castings of as good a quality can be produced at less cost by using cheaper material and labor. In these days, when inexperienced men have to be used, it is a better policy to place in his hands such materials as he can

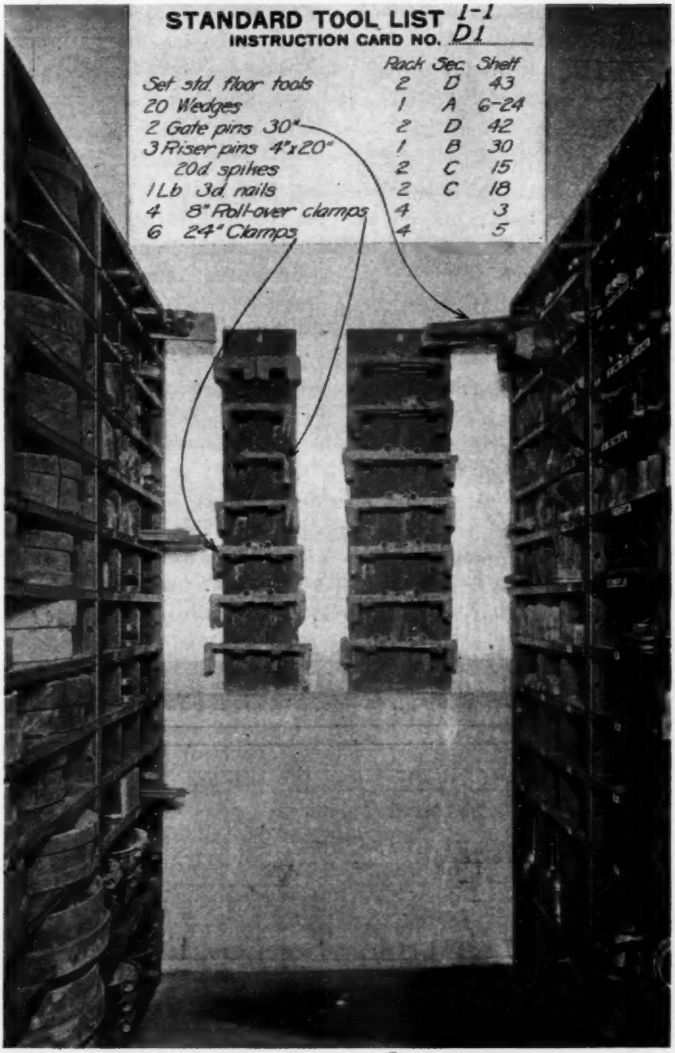


FIG. 3—A VIEW OF PART OF A FOUNDRY TOOL ROOM SHOWING HOW, WHEN TOOLS ARE KEPT IN DEFINITE LOCATIONS, THEY MAY ALWAYS BE OBTAINED EASILY WHEN NEEDED. A TOOL CARD IS MADE OUT FOR EACH STANDARD JOB; IT ENABLES THE MECHANICAL SUPERVISOR TO HAVE ALL THE NEEDED TOOLS AND SPECIAL EQUIPMENT FOR A JOB COLLECTED AND DELIVERED TO THE WORKMAN WHEN HE IS READY TO START ON HIS WORK

work with satisfactorily with the assurance that he will produce good results. From this can be seen the importance of having men at the head of the shop who are skilled enough, and who will analyze the results and can place the blame where it belongs.

Not the Fault of Cores

Once when the writer was working as a coremaker in a large engine plant, many small castings of a certain type were lost and the foreman of the foundry claimed that the cores blew. The core-room foreman, not knowing much about molding, had to take his word for it, but the writer investigated the case and found out that the castings did not have a head of metal high enough to force and hold iron in the projecting part. The molding practice was changed. The foundry foreman either did not know enough to analyze the cause or, not caring to take the blame, tried to make the core-room foreman the goat.

This same habit of always trying to place the blame on the other man, thus dodging personal responsibility, is one of the worst faults of most foundrymen as well as men in other lines of work. The organization of an efficient inspection department with men having a good knowledge of foundry practice will eliminate these troubles by carefully analyzing all losses.

Study of Equipment

In the matter of equipment, much has been done in the last few years to improve foundry conditions through the application of molding machines, sand cutting and mixing equipment and transportation and conveying systems, and most foundrymen have taken advantage of some or all of these means to increase their output. These devices all require considerable outlays of money and before making an installation, a study should be made of the advantages to be gained, determining what machine will best fill the particular needs at hand. In most cases, the answer is determined by the number of castings to be made from different patterns.

Those machines which are simple and permit of easily changed patterns offer more value to ordinary shops. Among such machines are the ordinary hand or air squeezer, the simple

roll-over drop plate, and the straight stripping plate machine. Very few foundries are doing work of such a nature but that it will pay them to investigate the possibilities of installing some of the simpler molding machines. In foundries having exceedingly large orders, the more complicated machines that combine several operations and the installation of elaborate sand handling plants are important factors.

Nearly every shop will find that it pays to have simple electric riddlers and sand mixers, for these machines will supply the molders with a thoroughly riddled sand and facing at a great saving in labor. Also there is a saving in the amounts of sea coal and core binders used, as compared with hand riddled sand. The use of these mixers will assist the foundryman in standardizing his methods of mixing. It certainly is suprising how often we still meet foundry foremen who, without giving the matter real thought, declare that such machines are no good, for they think they know it all and do not like to have others teach them anything.

It also is necessary, in order to get real value out of machines, to keep them in use and not let them lie idle any more than is absolutely necessary. An example of the losses accruing from idle machines was found in the foundry of a well known automobile factory. There were six molding machines in the brass department, which were used merely as ordinary molding benches with vibrator attachments. Although most of the work in this department was of a type almost ideal for squeezer machines, it was not fitted up on plates for use on these squeezing machines. There were 20 other machines in the gray iron department of this shop stored, or rather dumped, in storage bins and only two machines were in use on the cylinders, although good use was being made of rock-over machines for core work. The difficulty seemed to be that the foreman, having a little trouble in getting the squeezing machines and plates fitted up as they should be, got disgusted and turned back to the old way of doing the work.

Uniformity Desirable

Where possible, the make of machines should be kept as uniform as possible, for this means fewer kinds of pattern

FIG. 4—VIEW OF A CORE ROOM FITTED WITH WELL-EQUIPPED BENCHES. THESE BENCHES ARE PROVIDED WITH ALL ACCESSORIES WHICH TEND TO MAKE THE WORK OF THE COREMAKERS MORE EFFICIENT, INCLUDING TOOL BOX HOLDERS, SPECIAL CONVENIENT PLACES FOR HOLDING WIRES AND RODS, AIR HOSE FOR CLEANING BOXES AND SAND HOPPERS FOR HOLDING LARGE SUPPLIES OF SAND, KEEPING IT FROM SPREADING OVER THE BENCH

fixtures, greater interchangeability of work and all machines in use all the time.

Another important item to consider in foundry equipment is that of flasks. In only a few cases do the old wooden flasks pay, for their weakness and short life make them the most expensive in common use.

It is up to the foundry management to decide whether they want steel, iron or wood flasks, and careful consideration should be given to finding out what is best for any particular shop. The question of investment, absolute accuracy of flasks, ease in handling, standardization of pins, and length of service, are some of the things to be considered by the foundryman in studying this item.

The foreman who is a constant reader of foundry literature, learning of the kinds of new equipment being put on the market, is the one who is most apt to keep his shop on the best paying basis. The one who merely stays in his own shop, without seeking outside information, is the man who lets the world march on and then suddenly wakes up to find himself out of the running.

Machine Upkeep

The proper equipment having been installed, it is necessary to watch closely and have it always in running order. Flasks and boards should always be kept in shape and all repairs should be made as soon as possible. To be sure that this is done, it will pay to have some one man charged with the upkeep and make him responsible.

Molders, coremakers and other foundry help, as a general rule, know very little about the proper care of machine tools and cannot be depended on to see that the mechanical equipment is cared for in the proper way. Because so many foundrymen lack this training in machinery upkeep is all the more reason for having some machinist whose sole duty it is to keep the mechanical equipment in the best of condition. We all know that good machinery in good condition is one of the best paying propositions in any line of manufacture, and good machinery neglected is one of the most costly items in a shop, for it is money being thrown away.

Very few foundries have even a semblance of a tool room and yet the slogan, "The right tool in the right place when wanted", could be of value to every foundry as it is to practically all machine shops. Almost every person who has worked in foundries has seen the constant hunt for such tools as levels, hatchets, trammel points, special clamps, gaggers and

PATT. NO. 1-21 SEC C SHELF 4

CORE BOX NO. 1-21.1 NO. OF PARTS 2

NAME Intake pipe elbow

IN FOUNDRY		IN PATTERN STORAGE		IN REPAIR SHOP	
SIGNATURE	DATE	SIGNATURE	DATE	SIGNATURE	DATE
R.E.K.	3/6/16	G.A.G.	3/9/16	V.S.Day	3/7/16
J.H.H.	5/14/16	J.M.D.	5/18/1916	V.S.Day	5/17/16
J.H.H.	6/3/16	G.A.G.	6/3/16	V.S.Day	6/3/16
R.E.K.	6/10/16	G.A.G.	6/12/16	V.S.Day	6/11/16

FIG. 5—PATTERN LOCATION RECORD FOR EASILY LOCATING PATTERNS AND CORE BOXES. EACH PATTERN, LOOSE PIECE AND CORE BOX IS STAMPED WITH ITS NUMBER AND THIS INFORMATION IS RECORDED IN THE PATTERN BOOK IN ORDER THAT EACH PIECE MAY BE LOCATED AT ANY TIME

many times for decent riddles, rammers, shovels and many of the most commonly used tools.

A molder, when first starting to work in a shop, usually brings in a few tools of his own and inherits from the man who previously worked his floor some old tools, such as a shovel, a rammer, gate pins, etc. Each molder is generally fighting to retain possession of sufficient gaggers, clamps and wedges for his own needs and frequently has to use make-

shifts. Usually when he is through using clamps and special equipment, he will hide it away for future use, and if, in the meantime, another man has need for it, it cannot be found.

C1
1-1

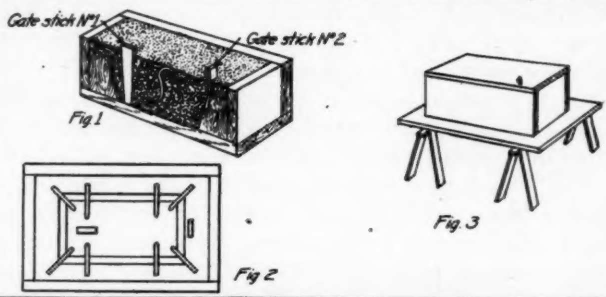
FORM 102
INSTRUCTION CARD
SHOP LABORATORIES
FOUNDRY DEPARTMENT

PART CRANKCASE CORE
ARTICLE Gas Engine PATT. NO. 1-1

FLOOR BENCH Core MACHINE STATION

STANDARD FLASK NO.
SPECIAL FLASK NO.
CORE BOX NO. 2 CORE PLATE NO. 18
SAND MIXTURE NO. 5
WIRE, SIZE RODS, SIZE 4x6"
NO. LOOSE PCS. NO. CORES 1

TOOL KIT NO. 2
RAMMER
FACING MIXT. NO.
TACKLE 2 iron stands
1 Lifting hook No.2
2 [illegible] clamps
1 Gate stick Sp.Tl 2,1-1
1 Gate stick Sp.Tl 3,1-1



ITEM	OPERATION ROUTINE	STANDARD TIME
	NOTE: MECHANICAL ASSISTANT. 4 GALLONS SAND MIXTURE NO.5, AND 1 CORE PLATE NO.18 FOR EACH CORE TO BE MADE, MUST BE PREPARED IN ADVANCE OF ISSUING WORK ORDER CORE BOX AND RODS TO BE AT ASSIGNED BENCH. LISTED TACKLE TO BE CALLED FOR BY COREMAKER AT TOOL ROOM WINDOW.	
1.	CLEAN INSIDE OF BOX WITH OIL WASTE. SET BOX ON STANDS.	0.004
2.	FILL IN A 4" LAYER OF SAND. SET GATE STICK NO.1 (SP.TL 2,1-1) (RAM AND PEEN)	0.012
3.	FILL IN A 2" LAYER OF SAND AND PEEN RAM.	0.005
4.	SET 8 RODS AS SHOWN. FIG.1&2. THE POINT OF THE RODS SHOULD ALMOST TOUCH BOTTOM OF BOX AND SHANK SHOULD PROJECT OVER FLANGE OF BOX AS AT A. FIG.1.	0.016
5.	SET GATE STICK NO.2 (SP.TL 3,1-1)	0.005
6.	FILL BOX 1" ABOVE TOP AND SET LIFTING HOOK AS AT B.	0.012
7.	BUTT RAM AND STRIKE OFF LEVEL WITH TOP OF BOX.	0.022
8.	REMOVE GATE STICKS. UNCOVER TOP OF LIFTING HOOK.	0.004
9.	LAY CORE PLATE ON BOX. CLAMP PLATE TO BOX.	0.010
10.	ROLL BOX OVER ON STAND. REMOVE CLAMPS.	0.008
11.	RAP CORE BOX AND LIFT AWAY FROM CORE.	0.008
12.	PLACE CORE ON OVEN TRUCK.	0.006
	NOTE: WHEN THROUGH WITH ORDER CLEAN BOX AND RETURN TACKLE TO TOOL ROOM.	
	TOTAL STANDARD TIME	0.11

FIG. 6—INSTRUCTION CARDS FOR MOLDING AND COREMAKING CAN BE USED TO GOOD ADVANTAGE FOR DETAILING SPECIAL INFORMATION BY WRITTEN ROUTINE OR SKETCHES. MANY TIMES THIS INFORMATION WILL PREVENT A LARGE AMOUNT OF WASTE EFFORT AND SPOILED PARTS BY ANTICIPATING IN ADVANCE OF PRODUCTION THE PRECAUTIONS NEEDED TO SUCCESSFULLY PRODUCE A CERTAIN PIECE

What molder, coremaker, or foundry laborer would not appreciate a good tool room and a storage place where tools and equipment could be obtained when needed?

With a central storage place, tools and equipment can be kept in repair and on hand in sufficient quantity for the needs of the shop. When a workman is through with special equipment, such as gaggers, clamps, riser pins, blocks, etc., it could be returned by someone whose duty it is to collect such things. Other tools, such as the more valuable special lifters, wrenches, levels, hammers, etc., could be checked out on the ordinary checking system. Fig. 3 shows some views in a foundry tool room, which has proved to a be a decided success.

Even in highly specialized shops there is need of this central tool room together with supervision over the tools used, for very few molders really analyze their needs to the best advantage. Much time could be saved if all the workmen were supplied with the best small tools for their class of work, for there are few foundries in the country where there is not seen a great variety of swab pots, lifters, slicks, vent wires, gate cutters, draw screws, etc. In this large variety of tools there are many which are inefficient and should be discarded.

In foundries with a great variety of work, the need for a tool room for the storage of the great variety of special equipment used is much greater and it is just as bad practice for a foundry to not have such a place as it is for machine shops to have no storage room for their jigs, fixtures and small tools.

Listing Tools Needed for a Job

It is becoming more and more impressed on foundrymen that before a piece of work is turned over to the workmen, it should be carefully considered by a planning department to see the proper flasks, boards, rods, gate and riser pins, facing sands and methods of making are placed in the hands of the molder before he starts to work.

This idea may be carried out further by having this information placed on a form and filed away for future use. This record will be of invaluable assistance to those having charge of the planning in the shop. Fig. 3 illustrates such a tool card

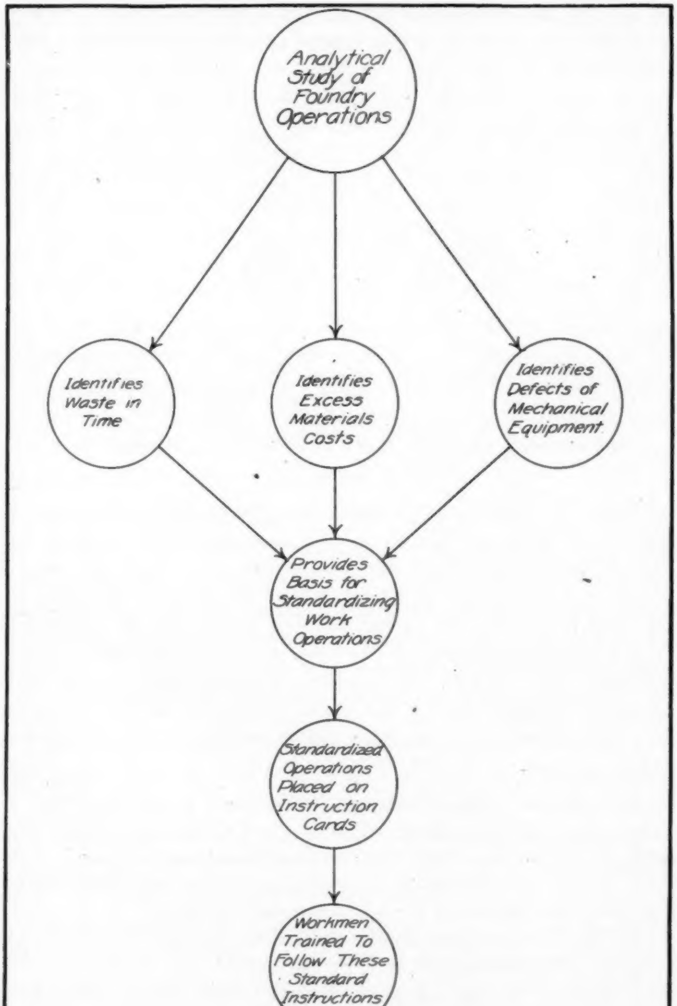


FIG. 7—CHART SHOWING METHOD OF PROCEDURE IN ANALYZING AND CHANGING SHOP CONDITIONS

as can be used to advantage by any foundry. Fig. 6 shows an illustration of an instruction card for use in coremaking and coremolding.

To make such a scheme effective, organziation of the shop forces is necessary, so that when an order reaches the foundry office, the production manager can turn the information, as to when and where the work is to be made, over to the mechanical supervisor. Then from the tool cards, the mechanical supervisor finds out what is needed for the work in the way of tools and equipment and has everything ready to start work at the proper time, without the necessity of having the molder or coremaker loaf around while some needed equipment is being found or made. Such a system also avoids having to hunt for some missing part or tool.

Summary of Method of Procedure in Analyzing Shop Conditions

When a foundry is in difficulties from the manufacturing end, the solution can nearly always be found from a study of one or all of the three factors which have been discussed. These factors having been analyzed in the light of the best in the foundry world, the causes of poor results should be ascertained. Knowing where the trouble lies, it is generally a comparatively easy matter to remedy the cause, but the remedy cannot be applied before the cause of the trouble is located. It is necessary, to get the best results, to take action along the following lines:

1.—Study the methods in vogue in the shop in question.

2.—Study the methods in vogue in the best practice in this line of work, or any other line of work which might suggest ideas.

3.—Clean up the shop and arrange it for the best work, providing storage places for equipment and materials.

4.—Standardize materials, mechanical equipment, methods, and times of operations.

5.—Route and dispatch work through shop under these improved conditions.

By standardization, we do not mean that one certain method or piece of equipment should be selected from the many and

then adhered to religiously forever, but we do mean that the best known way should be found and then used as a standard, while a constant search is being carried on for a better standard. We all know that standards are being raised all the time and are expensive to change, therefore, the firm which can set its standard further in advance of the others will find it unnecessary to change the standard as often as the others. Also, it is well known that those manufacturers having a definitely outlined course of procedure will almost always succeed, when often they would fail under the old hit-or-miss system.

The larger and more specialized foundries have had most of these ideas of standardization forced upon them by the hard school of experience. They have been compelled to use comparatively unskilled help, and have been obliged to train this help in the execution of specialized tasks, such as machine molding, sand mixing, pouring metal, etc.

Before much can be done in the way of planning and dispatching work through a foundry, the average shop will have several important things to do. First, it will have to be cleaned up. Get rid of the accumulated junk so often found in corners, gangways and bins. Storage places will have to be provided for all equipment and materials and methods devised for keeping track of this stored equipment and materials.

These storage places should be arranged in the most accessible places with men in charge to see that the equipment and materials are kept in their proper places. The arrangement of the foundry should be such that the work proceeds in a steady flow from the raw material yard, through the core and molding rooms to the cleaning and shipping departments.

With the shop in good condition, an effort can be made to standardize the operation routines and set rates on the different pieces, with some assurance that the rates will be correct.

These rates should not be set by estimates by the foreman, but should be made by time study averages. It is true that the average foreman's estimate of the time needed to do a given

piece of work is seldom accurate. When all operations are proceeding in good form, it still remains for the manager and all men working under him, to strive constantly to improve methods and results, for the manufacturing world is continually moving ahead and those who stand still are soon out of the running.

The Training of Young Men for the American Foundry Industry

By John A. Rathbone, Brooklyn, N. Y.

The Director of the School of Science and Technology of Pratt Institute, S. S. Edmands, who had expected to address you today, finds himself unable to fill this engagement personally owing to the conflict of other duties, and has delegated me to express his regrets at not being able to be present.

As I am just entering upon my active association with Pratt Institute, I hardly feel able to adequately represent it; but hope to give you some of the ambitions and practical workings of this unusual institution, which Mr. Edmands has most courteously given me.

Pratt Institute, located in Brooklyn, N. Y., was established and liberally endowed in 1887 by the late Mr. Charles Pratt, a practical and successful manufacturer. Mr. Pratt, a self-trained man, started his career without the advantage of specialized training, and it was his difficulty in acquiring such knowledge which prompted him, in later life, to establish an institution for the purpose of providing education in useful subjects not available in the usual school or college. Pratt Institute offers to both men and women, day and evening courses in a wide range of artistic, scientific, mechanical and household subjects.

Mission of Pratt Institute

The mission of Pratt Institute is not only to provide schooling for the individual, but also to do pioneer work as an institution in the development of new forms and kinds of industrial training suited to conditions as they are found, from time to time, to exist in this country. These two kinds of activity go hand in hand, and it is hardly possible to state along which line of effort Pratt Institute is accomplishing the most important results. An illustration of the pioneering feature of the Institute's activities was its business school, one of

the earliest in this country, which did good service in the training of students and showed the need of special education for commercial life. In time many similar business courses sprang up throughout the country, and the Trustees of Pratt Institute, seeing that this field of education was adequately taken care of by others discontinued its business courses, feeling that the Institute's energies might better be expended in other directions. Pratt Institute was a pioneer also in the establishment of one of the earliest manual training high schools, which, however, it discontinued some years ago because cities and towns throughout the country were rapidly installing similar schools and the need for a pioneer school of that kind at Pratt Institute no longer existed.

The Tanners' Institute

A more recent undertaking and one which may perhaps contain a suggestion for foundrymen is the Tanners' Institute, which comprises a co-operative working arrangement between Pratt Institute and the National Association of Tanners by which (*a*) young men are given a preliminary practical and technical training for positions of responsibility in the leather manufacturing industry, and (*b*) investigations of practical problems in leather manufacture are conducted for the benefit of the industry. This work is carried on at Pratt Institute, whose extensive industrial educational facilities are utilized for this purpose, including a well-equipped school plant for making leather. This undertaking is now in its sixth year, and has operated very successfully to the entire satisfaction of the National Association of Tanners, from whom, or from Pratt Institute, a printed report on this undertaking may be obtained on request.

During the 29 years of its existence Pratt Institute has given training to nearly 100,000 students, and its enrollment last year was in excess of 4,000 students. The Institute has a liberal endowment that enables it to make nominal charges for tuition, and at the same time provide expert teachers and unusual facilities. The receipts from tuition and from all other sources are used solely for the advancement of this work. Reference in this report will be made only to that portion of

Pratt Institute's work which has to do with the training of young men to take a useful and efficient part in this country's industries, with relation to the foundry industry in particular.

Industrial Courses of Instruction

A number of the courses of instruction which are conducted are of more or less direct interest to foundrymen. These courses may be conveniently divided into groups as follows:

(1) Mechanical industries group,
(2) Electrical industries group,
(3) Chemical industries group,
(4) Building industries group.

Within each of these groups are organized several courses both day and evening, each course especially designed to meet a particular need and varying in length from one to three years. The four groups comprise 30 distinct courses and accommodate a total of 1,700 students each year. Of this total, 500 are day students from all parts of the country, who devote their full time to the course of instruction, and 1,200 are evening students, who are employed in the industries of Greater New York during the daytime. An enumeration of all these different courses in detail and an explanation of the object of each, though interesting and instructive, is beyond the scope of this report, and is accordingly omitted.

Mechanical Industries Group

The courses of instruction of greatest interest to foundrymen are found in the "mechanical industries" group. Special mention is hereafter made of two of these courses: (*a*) A two-year full time day course of instruction in mechanical subjects preparing for entrance into practical and technical positions in a variety of mechanical industries, including the foundry industry; (*b*) a newly opened evening course of specialized instruction in foundry practice for molders and other foundry workers.

The object of this course, (*a*) just mentioned, is to prepare young men for responsible positions above the grade of skilled mechanics in manufacturing or in other lines of work in which a general mechanical training is essential or advantageous. It is of especial value to those already employed who find tech-

nical knowledge necessary for their advancement. It furnishes an excellent preparation for success in the rapidly increasing number of important, practical technical and executive positions in the supervision and conduct of manufacturing industries, especially those industries closely related to the machine trade.

While this course is not particularly designed to train men for foundry work alone, a large proportion of the instruction included in the course is admirably adapted to the training of the foundry specialist. Instruction in foundry practice and a considerable amount of actual work in the school's foundry are prominent features of this course. The students are familiarized with all the usual operations and departments of foundry work, including the cupola and the mixing of metal. The school's foundry is well arranged and equipped for doing a variety of light to medium work, in accordance with good practice. Other kinds of shop work given to the students are patternmaking, machine and forge work. This work in the foundry pattern shop, forge shop and machine shop is conducted as it is in commercial practice, and the same standards and excellence of work are required. The finished product is put upon the market or used in the school. Thus, a thorough comprehension of the processes of manufacture is obtained, combined with a large amount of practical skill and ability to direct workmen. The students in this course also receive thorough instruction in mechanical drawing and machine design. The work in the shops and drawing room is paralleled with instruction in applied mechanics, mechanism, strength of materials, power development and transmission, mathematics, physics and electricity. Extensive laboratories are provided and the training includes a large amount of experience in the repair, maintenance, erection and operation of the machines with which the laboratories are equipped.

Specializing in Foundry Work

A new optional arrangement is now contemplated, whereby students who enroll in this course, with the definite intention of seeking employment in a foundry after graduation, will hereafter be enabled to specialize in this line during their course of instruction to a greater extent than heretofore. The

idea is to assign these men during their second year as foremen over the first year students, with a view to developing their executive ability, and to give them a practical insight into foundry management and costs. This added practical training in foundry work would be supplemented by a special course of instruction in the class room, covering all of the departments of foundry work and management. A number of the graduates of the two-year mechanical course, just described, have entered the foundry industry in years past, and have given good account of themselves. Some of them are now successful foundry superintendents. In passing, it is worthy of comment that the number of young men who enter this course with the purpose of becoming foundrymen is very considerably less than the number which the course might readily accommodate. As has always been the case, foundry work is less attractive to the average young man with mechanical tendencies than are the various other mechanical industries. Possibly, also, there is a need for greater co-operation between the school and the foundry industry.

Evening Course in Foundry Practice

The evening course in foundry practice, before mentioned, is an experiment which is to be undertaken this coming year for the first time, at Pratt Institute. This course is arranged especially to help locally employed molders who are ambitious to broaden their practical skill and knowledge of modern foundry practice. The instruction wil include a series of talks on all the important features of up-to-date foundry methods, and the students will also be given practical work in the school's new foundry. There are many lines of instruction that suggest themselves which should be of tremendous interest and value to such men. For instance, few of our younger molders have had opportunity to acquire all around experience, and the instruction will accordingly be individualized for the purpose of broadening each molder's understanding of practical operations. Opportunity will be given to all to become familiar with the operation of a cupola and to experiment with different ways of handling a cupola. Another line of work will be in practical metal mixing. For example, most molders know that

silicon added to iron generally softens it, but few have had an opportunity to add known quantities of silicon to iron of known analysis, to cast test bars from the same, and to subsequently know the resulting effect on the hardness, the tensile strength and the elasticity. Practical experiments of this kind should give these students a very fair idea of the possibilities of iron mixing. Another line of instruction which should be of great value to ambitious, intelligent molders is the matter of costs. Few molders have any idea whatever of foundry costs. If they ever consider it at all, it is with the old crude notion of iron at one cent a pound, plus molding cost, plus some old percentage of the two to cover a lot of miscellaneous items which they know almost nothing about. As already stated, this course is an experiment and the trend of the same will be governed by the apparent needs of the students.

Interest of Brooklyn Foundrymen Sought

It is hoped by the school that Brooklyn foundrymen will show a live interest in this course, and will actively assist both in determining the proper subjects of instruction to be given by the school, and also by bringing favorably to the attention of their men the advantages of thus spending their evenings in the extension of their knowledge and understanding of foundry practice. An occasional practical talk from some of the leaders in the local foundry industry would be of great help and stimulus to the class. The success of this new evening course and the extent to which local foundrymen co-operate are likely to largely influence Pratt Institute when it comes to the consideration of extension of its courses of instruction in relation to the foundry industry. The school will welcome suggestions from the trade and will greatly appreciate all manifestations of interest and co-operation.

Training Foundry Chemists

In the enumeration of things which Pratt Institute is doing of interest to foundrymen, mention should be made of the chemical industries course, a two-year day course, which corresponds in general design and purpose to the mechanical industries course already described. This course affords young men practical and technical training for entrance into this country's

many chemical industries. Graduates of this course are well prepared to become foundry chemists, and the school has facilities for special instruction in foundry chemistry, for those who expect to enter that line of work. The training of these young men, while thoroughly scientific and technical on its chemical side, is strengthened and broadened from an industrial standpoint by the introduction of a large number of mechanical subjects. It is the aim to graduate men who will have, besides a knowledge of the principles of chemistry, practical skill in applying them to industrial work on a commercial scale, and the ability to superintend intelligently the processes of manufacture.

Not Kid-Glove Mechanics

Foundrymen will be interested to know that men trained at Pratt Institute are not "kid glove" mechanics. Before they are admitted to the various courses they must satisfy the authorities that they intend to follow the trade or enter the industry for which they are seeking preparation. It is impressed upon them throughout their training that a young man, to insure success in his industrial career, must expect to have to start at the bottom and be ready and willing to do his share of the dirty work, that only in this way can he hope to become qualified to efficiently direct the work of others. That they succeed in acquiring this attitude is clearly shown by the records of the large number of graduates who are now holding positions of responsibility throughout the country's industries, and I believe it will be conceded by foundrymen that these men are more valuable than the average apprentice trained in the industry in the old way. In admitting students to Pratt Institute, applicants must give evidence that they are fitted by character and by practical experience or previous training to succeed in the kind of work that they wish to undertake. Emphasis is laid on the maturity and general fitness of the applicant, rather than on his ability to pass set examinations.

Future of School-Trained Foundrymen

In closing I wish to suggest, but will not attempt to discuss, the question of whether the foundry industry is today prepared to receive school-trained men. Are the foundries ready to

co-operate with the schools in the training of the men? Are foundrymen prepared to send to the school some of their more promising employes, perhaps their own sons? Will the foundries absorb school-trained men after graduation, and will this school training work to the benefit of both the men and the industry? These and other questions must be answered in the affirmative and the answer translated into co-operative action if the school is to be a real factor in the development and progress of the foundry industry.

The Significance of the Fire Waste

By Franklin H. Wentworth, Boston

The awakening of a people to any great economic fact concerning their public or private welfare is always a matter of profound importance. The recognition by the people of the economic significance of our national fire waste has been retarded both in the United States and Canada by an attitude of mind bred by residence in a country of apparently boundless natural resources. Those who are born to great wealth and who accept such an environment without original thought, do not usually realize the sources from which such wealth is drawn until a curtailment of the supply precipitates an investigation. The thought to which the American mind has long been a victim, namely, that our natural resources were unlimited, has resulted in the disregard of our created resources as well. Our country, year after year, has suffered frightfully in the loss of its standing timber. This loss, with slight encouragement from man, Nature herself through the years will attempt to restore. Nature cannot, however, restore the artificial creations of man; and everything which is made for human comfort by man's creative energy requires a similar and sometimes a greater output of energy for its replacement.

Annual Per Capita Fire Loss

The United States department of commerce and labor shows that the average annual per capita fire loss in six European countries is 33 cents, while the average per capita loss in the United States is \$3.00, and in Canada \$3.07. Glasgow has an annual fire loss of \$325,000. Boston, smaller than Glasgow, has an annual fire loss of \$2,000,000. Berlin has an average fire loss of \$175,000 a year. Chicago, the same size, averages \$5,000,000 annually. The Berlin fire department costs \$300,000 a year; the Chicago fire department costs \$3,000,000.

These figures are sufficiently impressive, but they are not typical of these cities alone; they are typical of the entire United States and Canada as contrasted with Great Britain and the nations of Europe.

What is there in us, in our people, in our character, to explain this? What is the reason for this shameful contrast in the amount of property destroyed by fire? Is the explanation in a sense psychological? It is only within the last half dozen years that the United States has given any thought whatever to the conservation of its natural resources. But we are now entering upon a new era, and a great deal of attention and thought is being given to this problem.

The National Fire Protection Association has members in all walks of life. This fact brings us close to the people and their thought currents. We are engineers and special students of the fire waste, the social and economic results of which are often clearer to us than to the underwriters themselves. It is obvious to us that insurance rates cannot be reduced irrespective of the loss ratio without forcing insurance companies which mean honestly to pay their losses to retire. Capital invested in underwriting is not so irrevocably fixed as capital invested in public service corporations using public property and rights-of-way. Such investments can be controlled easily by the state, but capital invested in underwriting can easily seek other channels and withdraw from the states imposing undesirable burdens upon it; thus leaving the business world without the desired indemnity.

Scientific Underwriting Impossible

Recently in the legislatures of three states, New York, Illinois and Wisconsin, an investigation was undertaken of the methods and practices of the fire insurance business. This action found its impulse in hostility toward the fire underwriting interests; but all of these investigations developed the fact that scientific or satisfactory underwriting is impossible, and will continue to be impossible, until the criminally careless fire waste of the country is curtailed. It is obvious that these investigations represent an incoherent protest against the fright-

ful impoverishment of the nation by the fire tax. The people feel that the fire tax is too high. It is too high! Everybody knows that it is too high. But how can the fire tax be lessened except by attacking the cause of it? This is the question every representative body must be forced to answer.

Our waste of $3.00 per capita per annum means that every man, woman and child pays $3.00 a year for fire waste. That means that the man with the average family, his wife and three children—a family of five—pays $15.00 a year fire tax. The United States government in its report adds to this fire waste the cost of maintaining fire departments, which is as much more. This means $30.00 a year to the average family. If on some blue Monday in every year a representative of the government were to come around and ask us each for a check for $30.00 to pay our share of the national carelessness, then we should realize what we pay. But we do not realize that we pay it, because this tax is indirect.

The big manufacturers and the big merchants know that this fire expense is a tax. They equip their premises with automatic sprinklers. They put in protective apparatus. They get the lowest insurance rate they can because it helps them to compete; but the man in the street, the ordinary man, does not know how this fire waste is paid. Take wool, for example. Wool in the warehouse is insured—that is a tax. It is insured in transportation, and there it pays a fire tax. It is insured in the textile factory where it is worked up into cloth. It is insured in the clothing store, insured in the tailor shop, in the department store, and all the way along this fire tax is added to the cost, and when we buy a coat, we pay it. Every stock of goods that is insured carries this tax, and it is passed along to the ultimate consumer. The masses do not know that they pay it. They do not realize that when they buy a hat, or a pair of shoes, or a suit of clothes, or anything which goes through the regular channels of industry, production, distribution and exchange, they pay this tax. Not realizing it, they are indifferent to fire. They think fire does not affect them.

The fire loss in the United States and Canada for the last ten years has averaged $230,000,000 a year. What could we

do with that? We could build roads, build canals, improve our harbors, build battleships—if we have no less medieval use for our money. We could do a great many things with $230,000,000 a year. What country can stand a drain like that? Suppose we were to throw into the sea $230,000,000 in wheat or corn or cotton, or lose $230,000,000 out of our national treasury. Then we would realize that we are being impoverished by this waste. But we have lost the faculty of being moved by an ordinary fire. In Europe a $100,000 fire shocks the entire country. All the papers in continental Europe comment on it, wanting to know how it occurred, who was responsible for it, whether the conditions obtaining in the city where it occurred can be found elsewhere, so that such a fire might be duplicated. But here in America, if we take up the morning paper and do not find reports of two or three $100,000 fires we think it has been a dull evening.

We are the most careless people with matches on the face of the earth. In Europe, if you want matches you have to go where they are kept. In America matches are everywhere; on our bureaus; in our desk drawers; on the mantle-pieces; library tables; in all our old waistcoat pockets in the closet. If we wake up in the middle of the night and reach out and cannot find a match we feel insulted. Every match is a potential conflagration.

Everybody Touched in Pocket

The fire waste touches the pocket of every man, woman and child in the nation; it strikes as surely, but as quietly as indirect taxation; it merges with the cost of everything we eat and drink and wear. The profligate burning every year of $230,000,000 in the value of work of men's hands means the inevitable impoverishment of the people. This fearful loss, spread over the entire business world of America, is beginning to manifest its impoverishing blight. The people feel it without yet being awake to its cause. Their awakening is retarded by the prevalence of the foolish notion that the insurance companies pay this colossal tax. But how could they, and remain solvent?

They are mere collectors and distributors of that portion of this tax which is represented by their policies. Half of it they never touch; it falls upon the householder direct. San Francisco and Salem do not pay for themselves. We all help pay for them. And next year San Francisco and Salem, risen from their ashes, may help to pay for other cities. There is but one way in which we can escape the periodical paying for one another, and that is for us all to begin rational building construction and then protect what we have builded against fire.

Rational Building Construction

It is the ever-present conflagration hazard which makes any approach to scientific underwriting impossible. The conflagration hazard is not confined to any one city or state. It is present in every city and state in the Union. We have built largely of wood, and sooner or later we must pay the penalty unless we can find some way in which to protect our cities.

There is a way to solve this conflagration problem—not absolutely, but at least relatively. We cannot be expected to tear down our cities and rebuild them of fire-resisting material; the cities must be protected as they stand. In the heart of nearly every city there are streets crossing at right angles, along which for a very considerable distance are buildings of brick, stone and concrete. This shows a more or less complete Maltese cross of buildings which are not wood and which operate to divide the wooden-built district into quarter sections, and which might hold a fire in any one of these sections if they were equipped to do so. These brick and stone buildings are ordinarily valueless as firestops, because their windows are of thin glass and their window frames of wood. At Baltimore and San Francisco the conflagration attacked such buildings easily, breaking out the panes, consuming the frames, and converting every story of these brick structures into horizontal flues full of combustible contents. Brick and stone buildings are logical and capable fire-stops if the fire can be kept out of them. The small city that will trace out its Maltese cross of such buildings and equip them with metal window frames and wired glass will immediately possess the equivalent of

substantial fire walls crossing at right angles in its center, dividing it into four sections. By such a simple, inexpensive, but yet strategic procedure many a city may save itself from the destruction which now awaits only the right kind of a fire on the right kind of a night.

Imperative in Large Cities

I have referred in this plan merely to the smaller cities, but it is obvious that this form of protection is equally imperative in the brick, stone and concrete districts of all large cities where great values are housed in close proximity. Fires in the large cities entail an enormous waste because of the great values assembled there. We must come eventually to the equipment of all commercial, factory and office buildings with metal window frames and wired glass. This will mean the abolition of the conflagration hazard in our cities. Fires will then be unit fires, extinguished easily by a competent fire department within the building in which they originate; for the protection of window openings not only prevents fire from entering, but prevents fire from issuing out of the burning building. We may expect an occasional exceedingly hot fire to break down the defenses of an adjoining building, but it is obvious that a conflagration could not get under way among buildings of fire-resistive construction with properly protected window openings.

Having thus fortified city buildings one against the other, extensive fires within individual structures can be prevented by the use of the now well-established automatic sprinkler system. The automatic sprinkler applies the water without the help of human agencies while the fire is still incipient. It will operate in a dense smoke as well as in a clear atmosphere. It will not throw excessive deluges of water in wrong places as the fire departments are continually forced to do. With our window openings protected and our buildings equipped with such extinguishers, the conflagration hazard in mercantile districts will be eliminated. There will then remain for consideration our immense residence districts constructed almost wholly of wood surrounding the mercantile centers, like fagots

around a funeral pyre. We can lessen the loss here by the abolition of the use of wooden shingles.

The prohibition of the shingle roof, which is now generally recognized as a conflagration breeder, is today almost universal within city fire limits, and from the more enlightened communities it is excluded altogether. Burning shingles can be carried great distances by the wind or draft of a conflagration, and when they may alight in their turn upon other dry shingles, they make fearful havoc..

It will not be necessary to remove all shingle roofs immediately. An effective city ordinance might require all roofs constructed in the future to be of incombustible material, and that all roofs which shall hereafter require repair to the extent of one-third of their area shall be replaced with incombustible roofs. The modern shingle is thin, and the machinery which now makes it leaves a fuzzy surface which, after a period of drought, becomes like tinder. Without shingle roofs flying brands would not be carried over the brick centers of the city by the wind.

Habits of Our People Responsible

Outside of the abolition of the shingle roof, we must look for the protection of our homes to the corrected habits of our people. We must look carefully after the heating apparatus of our homes, giving them the constant and necessary attention demanded by receptacles containing fire. The building of proper flues and chimneys is especially necessary in connection with residences. Then we must have a general revision throughout the country of our building codes. We must stop the building of a certain shoddy class of buildings and we must limit the height of all buildings. In Boston we limit them to 125 feet. There is no reason why cities that can expand, and which are not bound by physical barriers should follow the example of New York and erect absurdly high buildings. They inflict an enormous expense upon the city for fire protection.

There are other matters, however, to which we must give proper thought. Among them is the best use of the fire-fighting agencies which have been established and which are maintained at a great cost by our people.

The mental habits of a people are a vital factor in affecting social progress. It is the mental habit of our people to assume that fire departments are maintained for the exclusive purpose of extinguishing fires. It is obvious, however, that fire departments have large possibilities for service in preventing fires; a service which is, I regret to say, yet largely potential. Every fireman, from the chief engineer down to the drivers and pipe men, should be regularly detailed for inspection service. Three or four hours a week for each man, going into basements, attics, courts and alleys, keeping down accumulations of rubbish—which spring up over night—locating the storage of inflammable oils and explosives, would keep the city clean of its most persistent fire dangers. Every fireman should in turn cover every section in the course of six months. One would thus check up the inspections of the other, and local conditions would become a matter for educative conversation about headquarters.

There is, however, a most important result to be achieved by such an inspection system over and beyond keeping the city clean; and that is the education of the fire-fighters in the exact physical character of the city. To know exactly which passageways are open and which are closed; to know which are fire walls and which are not; to have a mental picture of the exposures, the windows, the roof openings, the cornices, and all the other physical details important in fire-fighting, would so heighten the team work of a department that, like expert swordsmen, they could make their attack without loss of time straight at the vulnerable part. There are a few cities in the United States where such practice, partially in effect, has already demonstrated its singular efficiency. The citizens of every town and city should demand this sort of service from its fire department.

Up to the Individual

Then we must begin to place the responsibility for preventable fires upon the individual. It is difficult to do that, I know, and yet it can be done. In France, if you have a fire and that fire damages your neighbor's property you have to pay your

neighbor's loss. That is very educative! It would be a very good thing if we had such a law in America. We can fix responsibility, however, and we can change our attitude of mind toward the man who has fires. When we look upon the man who has a fire as one who has done an unneighborly thing; as one who is a public offender unless he can prove that he was in no way responsible for that fire; then we will have begun to make headway. We must have inquiry into the causes of all fires, not merely an inquiry into the fire which is suspected to be the work of some incendiary. Nearly every fire is the result of some carelessness; and the careless man must be held up to public criticism as a man who has picked the pockets of the rest of us; because that is what it is in its last analysis. When we get fire marshals in every state or province who shall inquire into the causes of fires, I believe we will begin to correct our personal habits in respect to the things that cause fires.

Fire Hazards of Foundries

Turning to the specific subject of fires in the properties of your industry I have made a special review of our fire records of foundries and have extracted from the same certain matter for my address today. Beside the common hazards present in every industry foundries have certain special hazards and I have enumerated these with a brief comment on each.

1.—*Preparing the Mold.*—The principal hazard under this heading is that of drying out the mold. This may be done with temporary stoves or furnaces placed directly in the mold, or with heat flues so arranged that the heat may be conducted to the interior surface of the mold, or by portable fuel oil torches or other similar means. In many cases excess moisture must be removed from the sand or else when the hot metal enters the mold it will form steam which, in expanding, would endanger the mold and might even cause an explosion if there were a very large amount of moisture present. The fire record of foundries, however, does not show that this operation has been a source of any appreciable number of fires.

2. *Core Ovens.*—Core ovens are usually constructed of brick and are heated by either hard coal fires, fuel oil or gas, whichever may be most convenient. The fire record shows that 15.3 per cent of foundry fires are traceable to the core oven. Nearly all of these fires could have been prevented by exercising a few simple precautions. Although woodwork has no place in a well-designed foundry, it is nevertheless found in a great many of them. Special effort should be made to remove any woodwork which may be near these core ovens or their flues. If this cannot be done, the woodwork should be completely covered with sheet metal or, better still, wire lath and plaster and Portland cement, or some asbestos covering. A flue or oven too hot to be touched by the hand is dangerous. Where the metal stack passes through the roof it should be protected by a metal thimble with an air space or some other equivalent, so as to prevent any possible heat from the flue igniting the wooden roof. Lumber or flasks should never be placed on top of core ovens. Care should be taken that core ovens are always kept in good repair and any cracks immediately filled with cement. Where possible, it is avisable to have the core ovens outside the building, having only the door opening into the foundry.

3. *Melting Metal.*—Records show that 42.7 per cent of foundry fires reported were caused by the cupola, the larger number of them by sparks from cupola. The remedy for such fires is a simple one: (1) All roofs within possible range of sparks from the cupola should be covered with non-inflammable material; (2) the cupola should be equipped with a hood or other device which would prevent sparks from being showered over the neighboring roofs; (3) all unprotected inflammable material should be removed from proximity to the cupola walls. Where fireproof roofs are not used they should be covered with metal with no exposed wood ventilators, frames or skylights. Special precaution should be taken to prevent the roof igniting at the point where the cupola stack passes through it. Charging floors for cupolas should be of non-combustible material, such as iron, brick or concrete. There is considerable danger of fire when the cupola is dumped, and

a hand hose should always be placed nearby for such emergency. The brass furnace does not present as serious a hazard as the iron furnace. It should not, however, be in proximity to woodwork, and never be used in rooms which do not have fireproof floors. At present brass foundries are frequently found in other than one-story buildings with the foundry floor of combustible material.

4. *Pouring.*—Before molten metal is allowed to run into the ladles it is necessary to warm and remove the moisture from the ladle. This is usually done by kindling a small wood fire in it, although in some of the more modern foundries this is accomplished by the use of a large torch and a portable fuel oil tank outfit. In either case this does not present any appreciable hazard if carefully done in a clear space in the foundry. Very frequently when the castings are poured the hot iron ignites the wooden flasks. Such fires are readily extinguished generally by throwing sand on them. Again, the hot metal may be spilled on the floor or accidentally come in contact with combustible material if there should be any in the construction of the foundry. The advisability of keeping all combustible material out of foundry buildings is obvious. If this is done there is very small probability of a fire starting from the handling of hot metal. There have been one or two instances in which fires were caused by an explosion of the mold at the time of pouring. This may be considered an unusual incident, probably due to excessive moisture. Many fires have been caused from hot smouldering flasks. As soon as the sand and castings have been removed from the flasks they should be placed either in an outside yard, away from buildings, or at some point where there is no possibility of their igniting buildings in case a spark lingers in them to be fanned into flame. Special precaution should be taken that wooden flasks are never put in storage in a building until several hours have elapsed since their use, to absolutely insure that there are no live sparks. Iron flasks do not present this hazard, and the only danger of fire from them which is quite remote, is when they are placed hot against some combustible wall.

5. *Cleaning and Finishing.*—The general processes of cleaning the castings are practically free from fire danger. Projections and gates are removed from castings either by hand or compressed air power chippers. An acid bath sometimes is used to clean the castings and remove any clinging sand and slag. Care should be exercised in the storage of these acids, which are usually sulphuric or hydrofluoric.

Tumbling is also a non-hazardous cleaning process accomplished by placing the castings in a slow revolving cylinder or receptacle where they become burnished by rubbing together. Coarse emery wheels are generally used to grind off projections and smooth up rough places. Emery wheel dust, if wet, may heat and ignite spontaneously. Burnishing, buffing and polishing are done with rag wheels. The principal hazards here are those due to hot bearings, spontaneous combustion, or sparks from the dust. A good collector system with metal blower pipes discharging into a fireproof receptacle is advisable. Lint should not be allowed to collect in the room and the receptacle should be frequently cleaned.

In General.—Many establishments which are primarily foundries carry on some other process in conjunction with the foundry work, and it is necessary to consider this feature in the proper study of the fire hazards of such a plant. Piping and pipe fittings are frequently dipped in asphaltum or tar to protect them from corrosion. This process should be carried on in a detached building, as fires have been caused by heating the pipes too hot so that the tar was ignited when they were dipped into the bath. Painting, lacquering and japanning are other special processes which are occasionally found in connection with foundries. Their hazards will not be considered other than to advise that this work be carried on in a separate building particularly constructed for the purpose. The increasing use of fuel oil for heating core ovens and small portable torches for numerous other purposes has introduced an appreciable hazard into foundries. This material should be stored in an approved manner, and special precautions should be taken to see that all piping, tanks, etc., are maintained in good condition and free from leaks. It is

advisable to have piping so arranged that in case of emergency the supply can be readily shut off at the source, and the piping drained.

Sprinkler Protection.—It was at one time thought that automatic sprinklers were not suitable for use in foundries on account of the supposed danger of water being discharged on molten metal. Experience has shown, however, that this does not present any danger whatever and that automatic sprinklers can be used just as advantageously in foundries as in other properties. The fire record of foundries indicates that sprinklers have been very efficient when installed in such properties, and that if the system is properly laid out there is very small chance of a fire reaching serious proportions. Sprinklers are particularly effective in foundries because of the fact that a great many of the fires occur in the night after smouldering for several hours. These fires might not be discovered until they had made considerable headway. An automatic sprinkler system will promptly check any such fires and at the same time announce their discovery if an alarm system is included in the equipment.

The Fire Record of the Foundry Industry

This record is made up from the fire reports received by the Association since October, 1906, and includes 475 fires in foundries making all kinds of castings such as iron, steel, brass, etc. Although there is considerable difference in these materials and in the details of making castings from them, the essential processes and hazards are very much the same, and therefore it seems quite proper to include all kinds of foundries in the same fire record.

One of the most interesting things brought out in the compilation of this record is that a large number of fires in foundries are caused by hazards not usually associated with such properties; that is, some other work on a small scale is carried on in the foundry in connection with the regular business. Two examples will illustrate this: (1) five fires were caused by dipping hot iron pipes (a product of the foundry) in asphaltum or tar in order to make them less liable to rust;

Foundries—Fire Record

Total Number of Fires Reported, 475

CLASSIFICATION OF CAUSES

Summary

Common Causes

	No. of Fires.	Per Cent of Common Causes.	Per Cent of Known Causes.
Heating	16	18.6	4.4
Lighting	12	14.0	3.3
Power	9	10.5	2.5
Lightning	4	4.6	1.1
Boiler (or fuel)	9	10.5	2.5
Oily Material	5	5.8	1.4
Rubbish (or sweeping)	3	3.5	0.8
Locomotive Sparks	19	22.1	5.1
Smoking	4	4.6	1.1
Miscellaneous	5	5.8	1.4
Total	86	100.0	

Special Hazard Causes

	No. of Fires.	Per Cent of Special Hazards.	Per Cent of Known Causes.
Cupola	112	42.7	30.7
Sparks from 87			
Heat from 14			
Miscellaneous 11			
Core Oven	40	15.3	11.0
Molding, Pouring and Casting	34	13.0	9.3
Furnaces	25	9.5	6.9
Hot Castings	8	3.0	2.2
Slag	1	0.4	0.3
Flasks	7	2.7	1.9
Fuel Oil	8	3.0	2.2
Dip Tank	2	0.8	0.6
Charcoal	2	0.8	0.6
Asphaltum or Tar Dipping of Pipes	5	1.9	1.4
Phosphorus	3	1.2	0.8
Miscellaneous	15	5.7	4.1
Total	262	100.0	
Common Causes	86	23.6	
Special Hazard Causes	262	72.0	
Incendiary	8	2.2	
Exposure	8	2.2	
Total Known Causes	364	100.0	
Unknown Causes	111		
Total	475		

(2) in another large plant a fire started in a kitchen which was part of the restaurant where the employes obtained their luncheon.

A study of the causes of foundry fires immediately brings out the fact that the cupola is still the most prolific cause, for 30.7 per cent of fires from known causes originated here, and nearly all these fires could have been prevented by such simple precautions as removing combustible material from the vicinity of the cupola, using only non-combustible roof coverings, and equipping the cupola with a hood or other device to prevent sparks from being showered over the neighborhood. Next to the cupola the core oven is the most frequent cause of fire. This hazard also could be almost entirely eliminated by giving careful attention to the construction of core ovens and their surroundings. Among the most frequent common causes are locomotive sparks and heating. The former is in part explained by the fact that many large plants have their own locomotives which enter various buildings, while the latter is no doubt largely due to the habit of constructing a rough office with a carelessly installed stove in the foundry proper for the use of the foreman or superintendent.

The record shows that 62.7 per cent of all foundry fires occurred at night, and for this reason they may smoulder for several hours unless a watchman is present to detect the fire. However, 32.9 per cent of all foundry fires were discovered by the watchman, which is a very good record. It is doubtful if there is any industry in which a watchman has better opportunities to prevent loss by fire than in a foundry, and consequently great care should be used to select a suitable man for this position.

An examination of the record of automatic sprinklers in this class of property indicates that they have been very successful, for there were only 2.5 per cent classed as unsatisfactory and only 3.8 per cent of fires in buildings equipped with automatic sprinklers resulted in large losses.

It may be said that most of the fires in foundries can be prevented by the proper safeguarding of heating devices. Also, the use of combustible material should be

avoided as far as practicable. If this is done and an automatic sprinkler system is installed, there should be very small chance of a serious fire.

Suggestions for Property Owners

In conclusion, I have set down certain general suggestions to property owners applying equally to foundrymen and other citizens which may help a personal consideration of this problem, and an understanding of what citizens may do to solve it, both for their own good and the good of the cities in which they live.

Property owners can do good service both in their own interest and in the interest of their community in this matter by first caring for the fire hazard of their own property, and then helping in any general local movement to eliminate the fire hazards from their city.

In a study of one's own property he should give specific attention to the following items:

Exposure Hazard.—If your premises are surrounded or exposed to property that is inflammable or otherwise hazardous, you are paying for this danger in your insurance rate. Study your location and your exposure hazard and the reasonable means of bettering your own property (such as fireproofing doors and windows and outside walls, extending fire walls above roof, non-combustible roofs, etc.), so as to minimize this physical exposure hazard.

Construction.—A large part of your insurance rate is always based on deficiencies in physical construction of your property. Study this (such as unprotected and horizontal openings, too large areas undivided by fire walls, concealed spaces, etc.) and ascertain how they may be reasonably remedied, and how such improvement will reduce your insurance rate.

Protection.—The best located and constructed property in the world without adequate fire alarm and extinguishing facilities may suffer from fire either in building or contents, or both. Burning contents often ruin so-called fireproof buildings. Study the deficiencies of your property in this respect and better them (by installing metal waste and ash cans, fire buckets.

chemical extinguishers, automatic sprinkler or standpipe systems, etc.), and you may find the investment highly profitable in the reduced hazard and rate.

Occupancy.—Every business has inherent in it certain dangerous fire hazard characteristics. Study the nature of your business and properly care for and isolate material or processes which may unduly occasion or accelerate fires.

Equipment.—Virtually all property must be heated, lighted and ventilated, and all this equipment, in addition to special apparatus required by almost every business, has fire hazard. Study the character of your equipment thoroughly before purchasing, and improve that which you now have.

Management.—Keep your property clean. Half of all American fire waste comes from careless accumulation of dirt and rubbish, and disorder. Teach your people cleanliness and order, and organize them to detect and extinguish fire, and how to call the public fire department quickly when necessity requires.

Every owner can apply in his factory, apartment house, warehouse or home the foregoing correctives, which constitute the essentials of fire prevention. He can also join any other good movements in community action to carry out this program and to study and get prepared and enforced reasonable legal regulations whereby such correctives may be demanded in the law, and finally can back up public officials in seeing that they are applied.

The American people are not dull in comprehension, nor are they slow to act once the necessities of a situation are made clear to them. The awakening manifested by the annual observance of "Fire Prevention Day" in many of the cities of the United States, by the appointment of fire marshals and the amendment of fire marshal laws; and by the teaching of the fire hazards in many public schools, indicates that we as a people will not much longer tolerate our pitiful impoverishment by fire waste. It is true that so long as our wooden cities stand they must occasionally suffer disastrous fires, with, oftentimes, shocking loss of life; but with the growing disposition to hold our citizens personally responsible for their carelessness

before the bar of public opinion, many of our most prolific causes of fire will disappear.

Our civilization grows daily more complex. Every man's life is becoming more inextricably linked with the lives of others. An injury to one is increasingly an injury to all. Out of a proper realization of these facts is coming a larger sense of civic responsibility. As citizens of a common country and brothers of a great international family, we may some day evolve a civilization in which there shall be no waste and in which the thought of the common good shall be the profoundest impulse in the hearts of our people.

Discussion

The Chairman, R. A. Bull.—Mr. Wentworth made the comment, in the early part of his remarks, that he sometimes felt that the American people were very slow to be impressed; I am sure we have all been very forcibly impressed by what he has said this morning. We are deeply indebted to him for the service he has rendered. He made the suggestion that this Association and the American Institute of Metals form a committee on fire protection. It might be thought that the A. F. A. Committee on Safety and Sanitation might properly include the matter of fire protection among its activities. Mr. Wentworth has discussed this question largely from a commercial standpoint, but it is so intimately connected with the safety of life that it would not be inappropriate for the Committee on Safety and Sanitation to take that phase of the work under its direction. What is your pleasure?

(It was moved and carried that it is the sense of this meeting that the matter be referred to the Committee on Safety and Sanitation.)

The Chairman.—Does anybody wish to discuss any phase of Mr. Wentworth's paper?

Mr. B. G. von Rottweiler.—I listened intently to this speech, and I think that what I have to say will interest you. My firm, not very long ago, gave me the job of putting up a new drop forge plant, and they were thinking very seriously of building this plant, 75 feet wide and 300 feet long, by the use of lumber in its construction. At the present price of lumber, that drop forge plant, after very extensive figuring, would have cost us $1.36 a square foot. The insurance on such a building would be high and I did not think that it would have been a very nice looking plant after it was finished. Not being satisfied with the lumber proposition I made an investigation and found that I could build this drop forge plant entirely out of steel for 98 cents a square foot, and the company which contracted to build the plant agreed to put it up in 60 days. I think these details bear looking into. There is a difference between $1.36 and 98 cents; we have a lower insurance rate, a better plant, and certainly a lasting one at less cost.

Results of Closer Co-operation Between the Engineer and the Foundry

A Symposium Covering Gray Iron, Steel, Malleable and Non-Ferrous Metal Foundries

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I

Co-operation Between the Engineer and the Gray Iron Foundry

By D. W. Sowers, Buffalo, N. Y.

Noticing from the schedule the secretary sent me, that I am set down to open the first chapter of this paper, as relating to gray iron, it occurs to me that the time allotted might perhaps be well spent in discussing and dissecting the title chosen from the engineers', founders' and owners' point of view.

To take you all into a secret, together with the chairman of our papers committee, Mr. Swan, and our genial secretary, Mr. Backert, most of one Sunday morning was spent trying to decide on a title which would convey to the members of the Association all of the importance we thought such a title should carry, keeping in mind, of course, that the importance of the title means the importance of the subject which it covers.

Dissecting the Title

To go into this matter a little further, let us dissect the title.

First—*Co-operation*—This is a word which lately has been so much abused. What does it mean? In this case it refers to a means to accomplish a given object in the least possible time at the lowest possible expense.

Second—*Engineer*—The woods are full of them, and some think some foundries are *too* full of them, but like any other profession, the great numbers must, and are divided into different classes.

For our purpose let us forget all of the classes except one, namely, the engineer who is purely a technical man, and who unfortunately has not had any practical manufacturing experience. This is the type of engineer who worries the foundry because he cannot see how the article he has drawn up is to be made, and in many cases does not particularly care. All he is looking at are certain dimensions, and what to him is most important in gas engine and other similar work, is to get a casting which will be an accurate counterpart of the curves and passages which his calculations have determined necessary to accomplish given desired results.

Now one word as to how the foundry management, particularly the superintendents and foremen should handle, what some are prone to consider this new race which is "butting into their particular bailiwick."

In this age, in all branches of manufacturing, we are accomplishing things that only a few years ago would be put down as impossible, and while I regret to have to admit it, my observation of the foundry business in the short fifteen years I have been in it, leads me to say I perfectly agree with some who contend that the average foundry has not advanced in methods of production as rapidly as have other metal lines.

I therefore feel that foundrymen generally have placed themselves in a position where it is up to them not only to listen, but to take into careful consideration requests and suggestions that are put up to them by the customer's engineer.

Third—*Foundry*—As the word appears in the title, it stands out alone and unvarnished, and while there are some exceptions—I am happy to be able to say the exceptions are growing—to the majority of those who come in contact not only with the word but with the plant, it means a picture of a dirty place filled up with black, nasty looking sand, pig iron more often than not thrown in any old kind of piles, and men of all nationalities and various colors shoveling sand in what looks to be any old kind of a way. So much for an explanation of the title.

What Co-operation Really Means

Now the question is, what can we, who are earning our living, or at least think we are, do to make conditions better?

First.—Personally that word, "Co-operation," is a good deal like a stick of dynamite. Properly handled it can do wonders; improperly handled or over-done, it can do as much damage as misplaced dynamite. After all, successful co-operation comes down to the common sense exchange of views and ideas—in this case between the foundry and the customer—which will bring the point sought into view by the shortest possible cut.

Some of you undoubtedly have heard of Sheldon, who has made a study of what he calls the "Science of Business Building". I saw this man's advertisement a good many times and passed it up as simply another efficiency scheme, but chancing to hear him at a luncheon one day was so impressed with the value of one of his formulas that I have tried it, and believe it might very well be applied to the word, "Co-operation." It is Q plus Q plus M equals S, which means, Right Quality plus Right Quantity plus Right Mode of Conduct equals Success. Let us apply it to our case, when it becomes quality of workmanship and material plus the right quantity for the price plus taking the trouble to find out what the customer wants, even though it takes time to dig this out, equals satisfactory goods at satisfactory prices.

We apply the above principles to our own business, and while it has often been necessary to get a higher price than some of our competitors, we have found that a little patience has, in nine cases out of ten, resulted in our prospective customer seeing the value of the service we render, and he has accordingly been willing to pay the price that such service costs, and is worth.

Therefore, on this first section, let us keep in mind that working with the customer in the way which Daniel Webster translates the word, "Co-operation," spells satisfaction to both parties to the contract, for he says, "Co-operate—to labor jointly for the same end,—to work together."

Co-operate With the Engineer

Second.—The word "engineer," itself already has been explained. Now the practical question is, what are we, who are in the foundry business, going to do with this comparatively new species of man, who has persisted on injecting himself

into the foundry business? It seems to me that the first sensible move is to practice what we have just discussed, namely, cooperate with him. He ought to know what he wants to accomplish, and if he does not, his boss is going to find it out, or if he is his own boss, his bank account will tell him before very long.

Therefore, will it not pay to be a little patient in co-operating with him, even if it is only to the extent of showing that what he is asking for is beyond the scope of *present* foundry possibility? But, at the same time we must keep strictly before us that it is up to us to do everything possible to eliminate the words, "beyond the scope," so we can say to him, even though it takes a few days or weeks, we believe it is possible.

Personally, I think that one of the best ways to handle a difficult job, which some engineers put up, is to take your man into the plant and show him just how the work is performed. I know from experience, not only with engineers of customers, but in my own case, that it does a tremendous lot of good to let the man who has designed intricate work, or caused to have it designed, see just how the molding is done, the cores are made, how they go together and the various difficulties which crop out in putting a difficult job through the foundry.

Just a word as to plain work. I believe many will agree that there is lots of "plain work", so-called, which is mighty expensive to the foundry, and which causes a big hole in the total profits, not so much from foundry scrap, as from the fact that castings are scrapped in the machine shop, which is worse. In some cases because of a matter of a few pits on a machined surface, in other cases because a certain portion could not be machined due to chills having been used. Isn't it a fact that it would have paid handsomely in such cases to have found out where the casting was to have been machined, in which event it would have been cast a different way up, even though it would have been necessary to have made ram-up cores to take care of some particular part that would draw only one way as the pattern was made?

I believe that every foundry should insist on drawings accompanying patterns, and that these drawings should be

plainly marked as to what surfaces are to be finished. The foundry superintendent or some one he delegates, should go over these drawings carefully and determine the important points of the finished casting from the customer's standpoint.

Looking Into Costs

Third.—As to the foundry itself, while some foundries, and the number apparently is rapidly increasing, are spending time to arrive at individual costs, many are not. With those who are not, I have absolutely no sympathy, for in the first place how can they expect to make the profit they should—in fact any profit at all—unless they know definitely what their work is costing, not on a rough old-fashioned lump tonnage basis, but as to the individual jobs? I know many will say that this is impossible without so much overhead as to take away the profits, but if they do not know what their costs are, how can they be fair to their customers and to themselves? I sincerely believe in the practice of showing a customer just how the price is arrived at, and if the customer still persists that the price is high, considering the quality and service he is getting, I then believe that any amount of time and money necessary to find out the truth of the situation is well spent.

Sometimes the "other price" the customer has, is given him by a foundry which does not know its cost. In such a case, sooner or later, the foundry is going to find out, or its creditors are, and then the customer has to look for another source of supply. In other cases a jolt on the question of losing a good order because you are underbid, causes the management to dig around on its own premises, and the digging process often brings out the fact that some certain operation was not figured as it should have been. This should be put down in one's experience table, even though it is only jotted down in the back of the brain, as it will be of value next time.

It may seem that the latter part of this paper has wandered away from the direct title, but I personally believe that all of the points brought out are necessary in taking into consideration the bringing about of closer co-operation between the engineer and the foundry.

II

Co-operation Between the Engineer and the Steel Foundry

By John Howe Hall, High Bridge, N. J.

Probably the best way to point out the desirability of co-operation between the designing engineer and the maker of steel castings is to give from the foundryman's point of view some of the difficulties encountered in endeavoring to execute contracts for engineers who are not sufficiently acquainted with foundry practice to design and specify castings correctly, and who have not learned the desirability of personal contact with the foundryman who is to make the casting.

I think most foundrymen will agree with me in saying that their difficulties in this line may be classified under two headings: *First,* difficulties with physical and chemical specifications, and, *second,* difficulties in trying to make castings of a design not suited for steel foundry work.

Specifications that have come to the notice of the author, that cannot well be executed, can be divided into several general classes. The first of these, is that specification which includes chemical or physical tests which are out of the ordinary. Thus at times the specification says that the steel must contain not over a very small amount of phosphorus or sulphur, and that amount so small that it can be secured only with steel of the very highest grade made in the electric furnace or in crucibles. In many cases it is found upon investigation that the price which is to be paid is not sufficiently high to warrant the use of very pure material in crucibles to meet the chemical requirements, or to warrant the use of electric furnace steel. It will frequently also be found, under these circumstances, that the castings do not need to be particularly strong nor tough, and when the engineer drawing the specification is open to conviction,

a compromise is often reached by which the regular steel turned out in the shop is used to execute the order with perfect satisfaction to all concerned.

Faulty Specifications

Again, specifications come in which call for a manganese content not over a figure which is now known to be quite low for good steel. Frequently the men who are bidding on the order are in the habit of using a great deal more manganese than the specifications allow, and know, from long experience and extended tests on their steel, that the higher manganese steel they make is more satisfactory than steel made in accordance with the specifications in question. A little conversation between the specifying engineer and the foundryman generally clears up this difficulty, and the foundry is allowed to use its regular grade of steel. This difficulty with manganese specifications probably arises from the opinion generally held 20 years ago that manganese over 1 per cent, or even a little lower, caused brittleness in steel. More recent researches, of course, have shown that under proper conditions a good deal more than 1 per cent manganese can be used in steel not only with perfect safety but with great advantage.

At the present time, owing to the high price and scarcity of ferro-manganese, the foundryman in many cases is anxious to use not more, but less, manganese, than the specifications call for. In a great many cases his engineers have made extended tests of their steel and found that by the use of special alloys or special procedure they are able to make perfectly satisfactory steel with less manganese than the specifications call for. In these cases, if the steel can be shown by tests to be perfectly satisfactory for the service desired, it is manifestly unfair to compel the unfortunate steel maker to use more manganese than he has found necessary.

Another case in which the chemical specifications become a stumbling block, is when alloy steel is specified and the foundryman is quite sure that a good grade of ordinary carbon steel is best for the purpose. It should be said in all fairness that this class of specification is rather rare, and that in most cases

it is accompanied by a failure to specify the amount of the alloy in question that is desired in the steel. Thus specifications are received calling for chrome steel, or nickel steel, or vanadium steel, with the amount of the alloy not specified. In some cases these orders are finally executed in a good grade of ordinary steel; in others the correct amount of the alloy to best suit the conditions is used by the foundryman; and in still others the order is turned down because it is not worth the foundryman's while to go to the trouble and expense of using the alloy in question for an order which does not amount to a great deal in total value.

Another class of troublesome specification, which is probably more often met with by makers of special steels for abrasive wear than by the ordinary foundryman, is the specification calling for a very high elastic limit in the steel. In some cases this elastic limit is higher than it is possible to reach with a steel casting; and in other cases, the equally troublesome fact is found that the elastic limit specified is so high that the steel is not machinable and considerable machining has to be done on the casting. Where the machining is done in the foundryman's shop, it is, of course, possible sometimes to rough machine the casting, then heat treat for the desired physical properties and then grind to shape. There are, of course, a certain number of cases where this procedure is necessary, because the steel must have the physical properties called for. But in the experience of the author, there are a number of cases in which the very high elastic limit is called for by the designing engineer with the expectation that the steel can be machined after heat treatment. Under these circumstances, of course, unless the engineer and the foundryman get together personally or by letter and have a heart-to-heart talk, some one's feelings are going to be hurt when the order is delivered.

In a certain number of cases, an elastic limit is specified which cannot be secured without special heat treatment of the steel, and the design of the casting is such that it is impossible to heat treat it without cracking it. Such cases, of course, can be taken care of either by modifying the elastic limit called for, or by so modifying the design of the casting as to eliminate the

danger of cracking it in the heat treatment. The author is familiar with a great many cases where this difficulty has arisen, and has seen it taken care of, sometimes by one method, sometimes by the other.

Correct Alloy Should Be Used

Still another class of specification which has come to the author's attention, is that in which an alloy steel of one kind is specified for a class of service in which, according to the experience of the foundry executing the order, an entirely different alloy steel will give very much better results. This, in some cases, may be an instance where the foundry could learn from the engineer, as well as the engineer from the foundry. Thus if the engineer is specifying the particular alloy steel that he does specify in the belief that it will be good for the class of service in question, but without definite experience to prove his belief, he may find the experience of the foundryman with that class of service of great value to him. On the other hand, the engineer may have made previous experiments with both classes of steel and have found that, in his particular case, the class he specifies is, for some reason or other, better suited to the service than the class of steel the foundry has been in the habit of furnishing. When this is the case, of course, the foundry can secure valuable information from the engineer. Of course, in some instances the engineer is specifying the new class of steel in an experimental way. If he and the foundryman get together and discuss the question, the engineer may find that it will not be worth while to try his experiment because the foundry has tried it already. On the other hand, the foundry may well find that the engineer has good reason for trying his experiment, and by keeping in touch with the order and ascertaining its performance in service the foundryman may secure valuable data.

Another class of specification that gives great difficulty to the foundryman, is that specification in which both the chemical analysis of the steel and the physical properties which it must show are given in the specification. Sometimes, indeed, this is further complicated by the addition of a specified heat treat-

ment. In many cases, of course, the analysis and the heat treatment specified will give the physical properties desired, but in far too many cases the foundryman on reading the specification finds that the physical properties called for cannot be secured in a steel of the analysis specified, or perhaps that the properties can only be secured by a heat treatment which is not allowed in the specification. Under these circumstances, the foundryman, in the lack of further data, is obliged to take his choice between making a steel which meets the chemical specification, and making a steel which shows the physical properties desired. Of course, if he gets together with the specifying engineer and has a little discussion on the matter, it can very soon be straightened out by altering either the chemical specifications or the physical specifications.

The Value of Standard Specifications

A little consideration of the foregoing discussion will show the great value to both the specifying engineer and the foundryman of standard specifications prepared by societies of recognized standing, and adhered to by both the makers and the buyers of castings; but even some of these specifications prepared by national societies of recognized standing sometimes fall into the error of over-specifying. Thus, until this year the specifications of one of our national societies, if literally adhered to, would have ruled out of consideration all the ordinary steel castings made in a certain shop. The reason for this was that the specification as it read gave the physical properties desired in the steel, and also the method of heat treatment by which those physical properties should be secured. As it happened, the heat treatment specified was perfectly satisfactory to secure the desired physical properties in certain classes of steel, but the foundry in question was accustomed to secure the physical properties by special heat treatment of steel of a different class, and this heat treatment was forbidden by the strict letter of the specifications.

Too much stress cannot be laid on the importance to the foundryman of securing uniformity of specifications for steel castings on the part of various representative societies. To

take a case in point, the author at one time had experience with an order for steel castings which formed parts of a steamship. It happened that these castings had to be accepted under three different specifications, all of them gotten out by well-known organizations. These three specifications so overlapped that it was necessary to secure a steel having a very narrow range of tensile strength. The steel as finally turned out passed all the specifications except one, and it would not meet this specification because it had about 4,000 pounds *too much* tensile strength. The inspectors who were working under this third specification refused to accept the castings because while they showed considerably more extension, contraction and bend than was called for, and while the elastic limit was perfectly satisfactory, yet the steel was *too strong.* It seems almost too absurd for belief, but efforts had to be made to so heat-treat those castings as to take 4,000 or 5,000 pounds off the tensile strength, and it was found impossible to do this without making the castings fail in some other part of the specification. After a great deal of bother, the matter found its way up to higher authorities and the steel, of course, was then accepted as being a good deal better than the specifications called for.

The Steel Founders' Society is making every effort to secure uniformity of specification on the part of the various bodies who issue specifications for steel castings, and the author feels that this society should make every effort also to further the good work.

Troubles in Designing

The second great source of trouble in the steel foundry which can be remedied by co-operation between the designing engineer and the foundryman, is the design of the casting. There are so many ways in which a design can be unsuitable for foundry work that it is not possible to mention all of them. Aside from the rather obvious error of specifying a casting so thin that it cannot be run in cast steel at all, the more common errors are, so designing a casting that it cannot be made without showing bad cracks, or designing it so that it cannot be made truly sound. The shrinkage of cast steel, being considerably higher than that of gray cast iron, is chiefly responsible for the

difficulties with cracked castings. In many cases, of course, this is aggravated by higher sulphur in the steel than is desirable, and by the necessity of pouring the castings very hot. In a great many cases a customer who has been buying gray iron castings sends in his patterns to the steel foundry and desires to have them executed in steel without change of design. The foundryman looks the patterns over, and sees, for instance, that they contain thick and thin sections joining at a sharp angle and that it will not be possible for him to provide fillets or brackets at the junction of the two sections sufficiently strong to hold the casting together. Again he may see that fillets at the junction will serve to prevent the casting from cracking in cooling, but he finds that the engineer is unwilling to allow him to use these fillets. If the designer and the foundryman go over this matter together, it will generally be found that fillets can be used and in some cases, of course, removed after the casting is finished; or again that the design of the casting can be so changed as to make the sections far more uniform. The author has known many cases, which are probably common to the foundryman's experience, in which the casting cannot be made without serious cracking unless the distribution of the metal in the sections is radically changed. In some cases the casting will crack in cooling in the mold, and in some extreme cases it will come out so crooked that it will break in straightening or else give great trouble in straightening, sometimes even necessitating straightening the casting hot.

Those of us who have had experience with the manufacture of alloy steels requiring special treatment know very well the difficulties of trying to execute castings in special steel that can readily be turned out in ordinary carbon steel. When patterns are sent in to us which were designed for ordinary steel with the request that we execute them as they stand, we are frequently in hot water, and finally either execute the castings with a change of design or let some other maker get costly experience trying to make them. In the cases where the pattern was designed for execution in cast iron, and is sent to us for execution in our special steel, the temperature of the hot water we get in is even higher. Our difficulties are considerably

increased by the fact that the shrinkage of our steel is unusually high, so that we may have a casting crack in cooling; we may have it crack in heating up in the furnace; and again we may have it crack in straightening, especially as it is not feasible for us to put heat on our castings after their treatment is completed.

When Castings Cannot Be Made Truly Sound

Sometimes castings are so designed that it is virtually impossible to make them truly sound. This is generally owing to the fact that the sections are so distributed that there is no place to put a sink-head of sufficient size or proper design to feed the fluid shrinkage of some heavy sections. The author has known many cases where conference with the designing engineer has led to a change in the pattern which enabled the casting to be made truly sound, and he regrets to state that he also knows of cases where no change was allowed and the foundryman just had to do the best he could. It is some satisfaction to state, however, that in a certain number of these cases he knows of the failure of the castings owing to almost complete unsoundness of some interior and important part, and that in those cases the designer of the casting generally had to accept the responsibility and to modify his design in accordance with the suggestions originally made by the foundry.

Readers of this paper may gather the impression that the author believes that the foundryman is always right, and the designing engineer always wrong. This is very far from being his opinion, but naturally being in a steel foundry he sees things from the foundryman's point of view, and believes that if he outlines the difficulties he has had in executing the designer's orders, and if the designer will co-operate with him by telling him the difficulties he has had with castings received, both the foundryman and the engineer may learn something to their advantage.

III

Co-operation Between the Engineer and the Malleable Iron Foundry

By G. F. Meehan, Chattanooga, Tenn.

The matter of co-operation between the engineer and the foundryman is a most important and vital one and one which, unfortunately, does not receive the attention it should. Malleable iron has many peculiarities which must be "humored", and it is natural to suppose that the foundryman whose daily work brings him in contact with these peculiarities should be in better position to know how to avoid trouble than the engineer who figures stresses and strains. Of course the work of one is just as essential as that of the other.

Experiments May be Necessary

The foundryman often finds that he is losing castings due to misruns, shrinkage, cracking in white iron, etc. It is often necessary for him to experiment in making certain castings until he has been able to secure the proper method of making them. Sometimes these losses are due to improper gating, but in most cases they are due to design. When sections are not uniform, it is often possible to avoid shrinkage and cracks by the use of chills. Some foundrymen use ferro-silicon in the ladle, at times, to stop shrinkage cracks. This method is not desirable, on account of its uncertainty. Usually the molder is given the ferro-silicon to put in his ladle, and he more than often reasons that, if a small quantity helps, a larger quantity will be even more efficacious. The consequence is that too much is used and the iron is spoiled. This is not the usual case, but the possibility involved makes the practice dangerous.

As a rule, the engineer is always willing to co-operate with the foundryman, but when they work at cross purposes, bad results are bound to accrue to all concerned. In one particular case, a very expensive pattern was prepared by a manufacturer.

This casting weighed a little in excess of 170 pounds. It was a conical shaped block with ½-inch walls and with a very intricate interior ribbing ¼-inch thick. As soon as the foundryman examined the pattern, he advised it would be impossible to prevent the castings cracking in hard iron, owing to the proportioning of the metal and to the design of the ribs. The customer did not desire to increase the weight of the casting by thickening the ribs. He satisfied himself that castings from his pattern could not be saved, and authorized the foundryman to make a new pattern, according to his own ideas, merely preserving his working points. The outside walls were reduced; the inside ribbing was curved and properly filleted, with the consequence that the weight of the casting was reduced to 150 pounds and there was absolutely no difficulty in making them. It was not even necessary to use chills. This is cited only as one instance of what co-operation will accomplish, and every malleable iron foundryman has many of these instances to deal with every year.

If the engineer in making his designs, will preserve uniformity of sections first of all, provide generous fillets and give consideration to the fact that the white iron casting is frail, that the metal sets quickly with a consequent quick and severe contraction, and will so design his castings that this contraction will not strain any of the sections of the casting, then much good will be accomplished for all.

Failures Not Due to the Iron

We all know of instances where malleable iron castings have failed and the blame put upon the quality of the iron. In a great majority of such cases the iron was of an excellent quality and the failure was due altogether to improper design.

Again, some engineers hesitate to design heavy castings in malleable iron, as they have the impression that it is not possible to anneal heavy sections. It is now well known that malleable iron is susceptible to annealing in any thickness. In fact, it is the practice among many malleable iron producers to cast with each heat, bars 3 inches square and to allow these bars to cool of their own accord, when they are broken for

the purpose of examining the fracture. If they are white throughout their thickness, they will anneal with as much certainty as will a casting whose section is ⅛-inch. It is to be observed too, that in some instances steel castings have been substituted for malleable castings. The origin of most of these substitutions can be traced to the fact that the malleable castings were either improperly designed, or were made too light. When they were changed to steel, the sections were made heavier, so much heavier in fact that malleable castings would have answered equally as well and would have been less subject to crystallization and oxidation.

If one will take the trouble to examine a carload of railroad coupler scrap, it is not at all unusual to find in it, old malleable iron couplers—the dates on which indicate that they have been in service from 10 to 15 years. This would certainly seem to speak volumes for this metal as desirable in the construction of railway equipment.

IV

Co-operation Between the Engineer and the Non-Ferrous Metal Foundry

By Clement E. Chase, Chicago

Perhaps we must go back to the dawn of the development of man's mechanical skill, to the bronze age, for the origin of the mystery and secrecy which have until very late years surrounded the production of non-ferrous alloys. In those days the supremacy of one tribe over another often lay, perhaps, in the precious possession of the formula and skill by which sharp edged weapons of metal could be matched against clubs of stone. Certainly we are far removed from that stage of civilization and relics of its way of thinking are as out of place in our industrial life as would be its weapons. And yet it is only in the last decade or so that real progress has been made in the interchange of knowledge of the composition and properties of the alloys. Even now there are makers who feel that the engineer meeting a new problem should be content to use some wierdly named alloy of their concoction without the slightest knowledge of its composition or physical properties. Equally archaic, it must be admitted, are those engineers who are willing to save themselves the effort of really investigating their problem and ascertaining the controlling conditions by trying something of which they know but little more than the brand name.

Futile to Guard Secrets

The growth of the spirit of frank exchange of knowledge of metals is in part a reflection of modern industrial practice in general and in part due to the fact that the jealous guarding of "trade secrets" is becoming increasingly futile. With the microscope reinforcing chemical analysis and the still older method of physical test, a vast amount of work has been done in late years to establish the laws governing the behavior of metals and alloys. Already an orderly array of logical phenomena, open to every serious student, has been substituted

for fragments of empirical knowledge and rule-of-thumb. The growth and spread of this general scientific knowledge of alloys has already removed the possibility of keeping most of the old secrets of composition, and those of foundry practice and treatment are threatened as well. Looking to the iron and steel industry we see that outside some of the practical details of manipulation in heat treating, there are hardly any trade secrets left, and everyone profits by the increased store of knowledge.

With this new condition of affairs, it becomes possible for the producer and the consumer, as represented by the engineer, to work together intelligently in attacking their common problem, which is, ultimately, that of choosing the most suitable material for each use. Reviewing what such mutual efforts have already accomplished, it may be said that a promising start has been made, looking at what they may yet do, it is seen how great is the field of opportunity and how necessary that the work be not allowed to drag.

In the non-ferrous alloy casting field, certain lines of co-operation suggest themselves as particularly worth while. For instance, the troubles of the New York Board of Water Supply with bronze or brass castings, although apparently not so widespread as with rolled or drawn materials, nevertheless will have a serious limiting effect on the use of these alloys in the future for such engineering purposes, unless it can be clearly shown that the trouble is entirely understood and that it can be avoided by changes in foundry practice. It is to the engineer's advantage that the reason for these failures be cleared up, for if he can rely on this material, he wishes to use it for those positions where corrosion is a serious matter and renewals to be avoided. It is to the brass-founder's interest that as many uses as possible should be found for his product, even if the biggest part of his output is devoted to less exacting types of casting. Such help as the Bureau of Standards is giving in its study of the causes of the cracking of brass castings is invaluable to the solution of the problem. Here is aid extended to both engineer and foundryman by an able ally, the disinterested government physicist and metallurgist. The Bureau,

in this work, has entered upon a comparatively untouched field. Many more urgent requests for investigations have been received than it is possible to undertake with the limited personnel available. The work of the Bureau in this line is something that it is directly to the interest of the members of technical societies to encourage and appreciate. It should be made unmistakably clear that this work of research is considered of great importance to the industrial advance of the country.

Work Should Be Carried On Jointly

As the vital properties of the various alloys are more clearly understood, it will become easier to select a certain type of alloy or formula with confidence that it is the best for the particular use that is in view. Investigation for the purpose of making the best adjustment of material to each set of conditions, should be carried on jointly by producer and consumer, foundryman and engineer. The one is best qualified to appraise the material and the other to analyze the requirements of the application. This opportunity for mutual assistance extends to the practical problem of design. The skilled foundryman knows the vagaries of shrinkage, piping and crystal growth peculiar to each alloy, as the engineer knows the theoretical shape of the casting most adapted to resist the loading. But as a finished casting is many steps removed from a blueprint, so oftentimes the very rib or extra metal added by the engineer for theoretical reasons is an actual element of weakness instead of reinforcement.

Possibly the most pressing matter in which there is a common interest is the preparation of intelligent specifications. No one would deny that specifications covering non-ferrous alloys are in a far more primitive state of development than those for almost any of the ferrous products. Many of those in existence are relics of an earlier and simpler day, and have been passed on from one engineer to another with perhaps occasional scissors and pastepot amendments. They do not suit modern demands nor modern knowledge of metals.

As a first step towards the construction of specifications for alloy castings the engineers and foundrymen who were working together enlisted the aid of the Bureau of Standards.

The *Proceedings* of the Institute of Metals for the last few years have recorded the progress made by them in the study of test bars. A number of points affecting test speciment results have been established, and the investigation has in addition given some valuable information concerning the particular alloy worked with, the copper 88, tin 10, zinc 2, bronze. This work, and other independent investigations, notably that of Webbert*, have, however, emphasized the fact that test bar results are seldom representative of those that would be given by specimens cut from the casting itself. The foundryman and the engineer are apt to look at this matter differently. The foundryman sees the difficulty in getting any standard test bar that will consistently give the strength of the actual casting and knows how wide a range that strength may have under the influence of the variables of pouring temperature, rate of cooling, casting design, etc. He is apt to conclude that a bar which will eliminate as much as possible these factors and which will reflect only the quality of the metal and the formula is most desirable. This is certainly true if what one has in hand is merely a comparative study between various alloys, or say, the purchase of ingot metal under specification. The engineer, on the other hand, thinks of the specimen test as giving him the actual strength of his casting. He has designed it for a certain loading, on the assumption that it possesses certain physical properties, and asks for the test to assure himself that the casting offered has those properties. For his purpose the test coupon should give results approximately as closely as possible to the average strength of the casting itself and should for that reason be affected by all the variables that do affect the casting.

It must be admitted that many designing and constructing engineers do not go very deeply into such matters as the factors affecting the strength of the materials they use, and are prone to assume that published test data on the strength of alloys can be readily duplicated in any and all castings.

Tests Should Be Representative

It is necessary both for safety and for satisfaction in the use of alloys that this idea be dispelled and tests representative

*L. P. Webbert, Proc. Am. Soc. Test. Mats., Vol. XIV, 1914, p. 146.

of the actual strength of the casting will best do it. In making specifications this will doubtless involve calling for different sets of physical properties for castings of various thickness, and this presents a large problem in collecting data, and conducting experimental work to supplement it. The committee of the American Society for Testing Materials that has in hand the preparations of specifications for sand-cast alloys is endeavoring to collect such data, and has urged that anyone who has test results on specimens taken from actual castings send them to some central point, as the Bureau of Standards, with as complete a history of the test as possible.

Where more than chemical limits are required to be met by alloy castings, the additional tests are usually either in tension or compression. For some uses of these metals, such as in bearings, it is by no means certain that these tests are the best to determine the suitability of the metal for the service it is to be put to. At present certain engineers are calling for Brinell tests on bronze alloys used for movable bridge bearings, while retaining the customary compression tests. It is the intention, if the Brinell test proves adequate, to abandon the compression test. Because certain tests have always been made for the acceptance of certain products by no means proves those tests to be ideal. The more directly the test ascertains the qualities of a metal which will make it satisfactory in service, the better. Recent research in bronze has pointed the need for a check on oxidation. There is a constantly widening use of the microscope in studying alloys, and with the determination of the relation between structure and service qualities, it is likely that microstructure may be considered in future specifications. Such revisions of testing methods call for study in common by the foundryman and the enigneer.

What is Elastic Limit?

These matters are closely allied with another of even greater importance, a problem that the worker in non-ferrous alloy castings shares with everyone else who has occasion to study the physical properties of metal. This is the determination and significance of the "elastic limit".

Despite all that has been written and said in explanation and argument concerning this term there seems to be more confusion than ever before. That the useful limit of the strength of a metal in static service is reached when a certain (disputed) amount of plastic yielding has taken place is not denied, nor that a repeated stress causing an accumulation of permanent sets will eventually cause rupture. The trouble is that the change from the truly elastic to the plastic state is so gradual that the determination of the first inelastic action is largely a matter of the refinement of apparatus and the skill of observers. So the approximate point at which plastic action commences is located instead, by several methods and to several degrees of accuracy. Unfortunately, the tendency is to give each of these approximations a different name and then to confuse these names hopelessly by applying them indiscriminately.

Workers in mild or medium steel are fortunate in that this material at a certain clearly marked point in loading shows a "marked increase in the deformation of the specimen without increase of load". This is the yield point. It is an easily determined value, is not far removed from the point at which strictly elastic action ends, and has greatly simplified structural steel testing. Unfortunately, it is not a phenomenon common to many other metals and it only serves to complicate matters to call some approximation of the beginning of plastic action in another metal, a yield point. "Yield point" should be left to those metals fortunate enough to possess it, and some other term adopted for the rest.

Any precise, scientific definition of either "proportional limit" or "elastic limit" seems to place them outside the possibility of determination in commercial testing. What is needed is something in the term or in the units in which it is measured which in itself would indicate the degree of precision adopted. If we say a bar is half a foot long, 6 1/16 inches long, or 6.0059 inches long, the degree of refinement of the measurement is indicated, taking it for granted that apparatus and methods are consistent with the number of decimal places. It would be absurd to report that the elastic limit of a specimen is 27,346.089 pounds per square inch. But it is entirely practical and signifi-

cant to say that at 27,000 pounds per square inch a set of 0.01-inch, or 0.001-inch or 0.0001-inch per inch of gage length first occurred.

Hope may lie, too, in the development of the proportional limit idea, adopting a sort of "commercial proportional limit" to be determined according to standardized methods.

There are nearly as many opinions on the subject as there are men who have come into contact with it, but this is too big a problem to be settled by any one man, or single society. However, as it is apparently not being cleared up at all by random discussion or the trend of practice, it should be recognized as a problem of national scope and importance, and handled as such by co-operation between manufacturers, physicists, metallurgists and testing engineers, all who are competent to deliberate and who would be affected by the decisions.

Co-operation is Needed

The perfection of American specifications to insure the selection of thoroughly satisfactory products of each type, is by no means the engineer's concern alone. Foundries that have had experience under foreign specifications in the last couple of years can appreciate what it would mean to have foreign engineers use American specifications in placing orders in this country. To make this possible in the face of the natural prejudice for a specification of the buyer's country, our standards must be high, the tests a complete check on suitability, the specifications must be widely used in this country and they must be accessible to, and familiar to, the foreign engineer. The work of the U. S. Department of Commerce in undertaking to distribute abroad through the United States consuls certain specifications of the American Society of Testing Materials translated into foreign languages, gives a vision of the possibilities of such a course. For one interested in non-ferrous alloys, it calls to attention the amount of work that must be done before specifications for them could be so distributed.

Discussion—Results of Closer Co-operation Between the Engineer and the Foundry

The Chairman, R. A. Bull.—Mr. Sowers presented his part of the symposium in a very interesting way. Does anybody wish to discuss Mr. Sowers' contribution? If not, we will take up the next paper on "Steel". Mr. John H. Hall, the author of that paper is not present, but probably several of you have read the paper, and I would like to call your special attention to his remarks on the manganese content and the ignorance of a good many engineers as to the maximum manganese content permissible in steel castings of satisfactory quality. I know personally that that is a matter which has come home to a great many foundrymen in a very serious way, and there is much opportunity for enlightenment among engineers along that line. Mr. Hall also makes some appropriate remarks on elastic limit, some engineers specifying a much higher elastic limit than is permissible, considering the other qualities desired. That elastic limit proposition is important, also the method of determining it. He also makes some remarks on alloy castings. some engineers specifying chrome steel or chrome nickel steel without knowing what is best for their use. If they would keep closer in touch with the foundryman, they would frequently get useful information as to the alloys best to use.

Dr. Richard Moldenke.—I should like to say a few words in connection with this very interesting symposium on the advisability of closer co-operation between the engineer and the foundry, and would call your attention to the desirability, now that we see the engineer is coming more and more into the foundry, of getting him in the family as quickly as possible. If you go through continental Europe you will find that the engineer is the man who runs the foundry. You do not find

foundries run by men who have advanced from the ranks, but by trained engineers. Consequently the questions we have to fight out here, in convincing the engineers of our customers that they are "off" occasionally do not come up over there at all. My advice would be to all you gentlemen who have sons, to give them a technical training, so that when they come into the foundry they can carry through matters technically correct.

Now on the question of the test bar and its lesson to the foundryman. I wish to state that realizing the impossibility of getting any information of what a casting is from the foundryman's standpoint unless you actually break it or cut a piece out of it, the foundryman has come to use a test bar entirely apart from the casting, so made that it gives him the very best chance in the world to find out just what the quality of the metal used for the casting is. I am afraid you cannot get away from this. If you put coupons on your castings, you will not realize what you are after, because coupons at the bottom of a casting, coupons at the middle and coupons at the top of the same casting are three different things for the same iron poured; the shrinkage and other physical problems involved are all so entirely different from what goes on inside the casting itself, that such a method of testing is unreliable. The only thing to do is to study the casting in relation to the properly made test bar, and then you will know something about it.

The third question is that of export specifications. Mr. Walter Wood and I were over on the other side of the water twice and worked on international specifications; we got things pretty well started when the war broke out. I do not think you will succeed, no matter what is being done in the way of translating American specifications and sending them to Europe. They will not buy on them. I believe that the only specifications that will be used will have to be of an international character, specifications on which every country has been consulted and in the making of which every country has been represented. Sweden and Germany, for instance, will never buy on English or French specifications, nor will England or France buy on German specifications. That will never come.

All attempts to get Europe to use our steel specifications have failed. It was only when we, the cast iron men, went over to them and said, "Let us talk this over and make up the best specifications on which we can all agree"—then there was a chance, because then each one felt that he has had his share in the making of the specifications in question. So I would suggest that we go and work with these people and jointly agree on something rather than try to force our specifications upon them. No matter how good our specifications are, they won't believe it on the other side.

Mr. B. G. von Rottweiler.—We have heard Mr. Sowers' and Mr. Chase's most interesting papers, and I thought this was a very opportune time (with your kind permission) to really wake up these foundrymen, and call their attention to the matter of co-operation between the engineer and the foundryman. Now it is necessary for the engineer to be acquainted with the up-to-date foundry practice. Most of our engineers, at the present time, know very little, especially designing engineers, about foundry practice, and if some of these gentlemen would get together with the practical foundryman, they would find out that they could change their designs to such an extent that they could cut the cost of castings in two.

For instance, I have seen patterns that came into the foundries from which castings were almost impossible to make; the loss on them was practically 50 per cent. At the same time, the customer, or the engineer who represented his concern, insisted that he wanted those castings that way. The practical foundryman turned around and said, "We can make them that way if you wish, but if you would allow me to call your attention to a little change which we could put in that design, it will make a job for the molding machine, and we could then save you a lot of money." The engineer was persistent, and said, "No, that's the way I want it." He did not know anything about foundry practice; if he had listened, he would have had better results, and the price of his castings would have been lowered.

You may ask me, what is the next step to take in order to get together? That is a very easy one; foundrymen must listen

to engineers, and engineers to foundrymen. The foundryman does not know it all, and the engineer does not know it all; and in order to get better results in what is to come (and by what is to come I mean competition—particularly to foreign competition after this war is over) if we do not produce castings at a lower price than we are producing them now, we will have to take a back seat. In the first place, we must have system and efficiency, and know what we are going to do in the foundry before we begin a job, not find out later, after we have had all our losses, but find out at the *beginning;* and to do that, it is necessary to get together, the engineer with the foundryman, so both are convinced about the final results.

If you advise one of your customers that this is the thing to do, to save him money, he will become a lifelong friend; in other words, you will always have his business. But the thing that I have seen in this country is that the two do not get together. Why, I do not know, but I believe that this co-operation is coming. They must get together; foundrymen must listen to engineers and engineers to foundrymen, and these gentlemen who have establishments in this country, and who work along these lines, will certainly be able to tell a very nice tale of their results.

Symposium on the Influence of Gating on Castings

I

Gating Gray Iron Castings

By B. D. FULLER, Cleveland

When the subject of gating was first handed me by the chairman of your papers committee, there flashed through my mind the picture of a pasture field surrounded by an old-fashioned rail fence, the entrance guarded by a barred gate and inside the gate a safety first sign-board bearing the warning, "Look Out for the Bull". Perhaps 'twould be well for me to hang out such a sign before attempting to talk to you foundrymen on such a subject. It seems but natural to expect the average foundryman to remark, upon viewing a scrap casting (particularly if it be the work of another), that "'Twas not gated properly," or "Did not gate it in the proper place," and here permit me to suggest to aspiring "Foundry Professors" a course in "Proper Methods of Gating Castings, Light and Heavy". *No charge for the suggestion.*

By gate or gateway is denoted an entrance, and you are well aware that it is expedient in some cases to have a number of small gates or entrances whereby the inflow can be checked and the dross collected in the same manner as, for instance, the numerous turnstiles at the ball park entrance where the stream of "fans" is checked, and the pasteboards representing a certain amount of filthy lucre are lifted before the properly trimmed mass is permitted to enter. Again there are cases where it is best to open the flood gates and have the filling job over with as soon as possible.

Then there are times when a casting may be gated to fill either slowly or rapidly, as a pavement may be cleaned in time by the stream from a garden hose, but much more rapidly and efficiently by the use of a fire hose.

There is nothing about the molder's work requiring more consideration. Imagine a pattern resembling a picture frame. In place of the picture suppose the frame be filled by a light matting or grating. To gate this on the outer edge of the frame would mean that we add the weight of the gate in a place where we already have too much weight in comparison to the center. It also means that the hotter iron will remain in the frame or heavier part and, as the center cools first, the shrinkage of the frame will take place after the light center is set, causing distortion or cracking. Such a casting should be poured through flat gates set across the light checkered centers, introducing the hotter iron and added weight where it is needed.

A case where just the opposite method has proved the better, is that of a light cup-shaped industrial motor frame. Imagine the rim or lip of the cup to be machined to receive the bracket. Five holes are drilled in spots close to the edge of the rim. Gating this in one spot on the circumference causes a hard spot where the flow of iron meets just opposite the gate and difficulty is encountered at this point when machining or drilling is attempted. A gate provided with a channel extending entirely around the casting with a number of sprues leading from the channel to the circumference of casting, will distribute the iron more equally and hard spots will be avoided.

How the Horn Gate is Used

Another very successful form of gating is the well known "horn gate". Suppose you were casting brackets with heavy hubs and light frames similar in shape to an ordinary wagon wheel, with the hub quite heavy in proportion to rim. Ordinarily this would be gated on the rim, but by running the gate under the rim and into the bottom of the hub, allowing this part to fill first and the iron to spread out evenly from the center, a better casting will result.

You have, no doubt, seen multiple molds with one casting on top of another, six or seven high, each being provided with its own gate. This form of gating is very satisfactory in casting deep molds. For instance, consider a turbo-generator frame, which may be 15 or 16 feet in diameter with a 9 to 10-foot face. It is cast on its side and is cored out intricately. The gate in

this case first receives the iron at the bottom of the mold and after the cavity is partly filled, the pressure on the bottom gate increases, causing the flow to be checked and the next sprue above to do its share of the work. This sprue, which is inclined from the down-gate to the casting, continues to handle the flow until a certain elevation has been attained by the rising metal, when the next sprue in turn takes up the work. Two or more down gates, for double pouring, generally are used.

In connection with this sort of work a brick runner, which may be made in sections that fit one into the other to any desired height, will be found an excellent thing to use. It is not possible, where these runners are used properly to have a gate strain or cut. Strained or cut gates are the cause of many lost castings. A large pouring basin should be used in connection with the brick runner. A basin holding as much as an ordinary wash tub usually will be found satisfactory. It generally is best to have the down-gate, built of brick runners, extending like the neck of a funnel directly from the bottom of the pouring basin. Plug the top of the down-gate with a cast tapered plug provided with an iron handle extending above the basin. This plug will represent the ferrule upon a cane, the handle being above the rim of the basin. When pouring, the plug is not removed until the basin is full, which makes it certain that only clean iron will enter the gate, as the slag will float on top of the metal in the basin.

Why the Mold is Inclined

In some cases, such as large flat plates, it is better to incline the mold, pouring from the lower point and forcing the iron gradually uphill. Have you ever noticed that when pouring molasses into a skillet upon the stove it will flow around in a thin body until it meets at a given point with a sort of seam, any foreign matter which may be on the face of the skillet being picked up and carried to this meeting point? It is to avoid the iron flowing in this manner over the surface of a flat bed-plate that the mold is inclined.

As mentioned previously it is sometimes better to pour the entire amount of metal into the mold at one time. An exam-

ple of this is found in a mechanical casting process used in making pipe-shaped rolls, packing rings and similar castings. The mold, which is of metal, is revolved at a high rate of speed. The iron is introduced while the mold is revolving, much as you would reach into the end of a revolving piece of pipe with a long-handled dipper and upset the dipper, except that in this case instead of a dipper, a sort of a trough resembling an old-fashioned horse trough is used in order to distribute the metal evenly and instantaneously. The proper distribution is accomplished by the centrifugal force of the rapidly revolving mold.

There is a wide field for ingenuity in gating molding machine work, particularly the lighter castings such as are made in snap-molds from metal patterns. For general utility in this class of work, the saw-tooth skimmer is excellent both on account of its simplicity and its efficiency. A stick of any desired length with saw teeth cut in one side will do the work. For ordinary use the stick, or gate, should be approximately ½ x ⅜ x ¾-inch. It should be placed in the mold with the teeth in the cope, so that the iron will flow against them on its way from the sprue to the mold. The teeth will collect and hold the dirt.

Numberless examples of gating certain castings could be given but it is not my intention to go into this subject exhaustively at this time. "The Properly Proportioned Down-Gate", "The Proper Cutting or Shaping of the Sprue", "The Formation of the Runner", "Different Styles of Skim Gates and Their Utility" are subjects for further consideration.

II

Gating Malleable Iron Castings

By A. M. Fulton, Pittsburgh

The correct gating of a malleable iron casting is just as important as a proper mixture of iron, and should have as much thought devoted to it as to any other feature connected with making the mold or pouring the metal. Irregular sections and sections joining at right angles prevail to a large extent in malleable iron castings used in railroad car and heavy construction work. This condition causes an unequal cooling which creates shrinkage and checks at the heavy or adjoining sections. These conditions must be met by the foundrymen. I might add that some manufacturers have made a big error in the past by overlooking this important feature; in many cases they were not absolutely sure that all shrinkage was eliminated. In recent years this difficulty has been eliminated to a very large extent, and today malleable iron is universally recognized as a valuable metal in construction work.

Many patterns are condemned if the loss of castings is above normal and the trouble is attributed to the design, when it should have been charged up against the gating. Such criticism, for the most part, occurs when the foundry foreman is extremely busy and does not take time to think out his part of the problem.

Should the order call for sufficient castings, requiring metal patterns, the pattern shop foreman usually proceeds to make and gate the pattern according to his previous experience. But if he is in doubt as to the best location for the gate, this point should be discussed with the foundry foreman. These two departments should work in unison, having in mind the following points:

First, can the casting be fed from the proposed gate, excluding slag and preventing misruns?

Second, should the heavy or unequal part be fed with a riser located at the top of the casting as shown at Nos. 1 and 2,

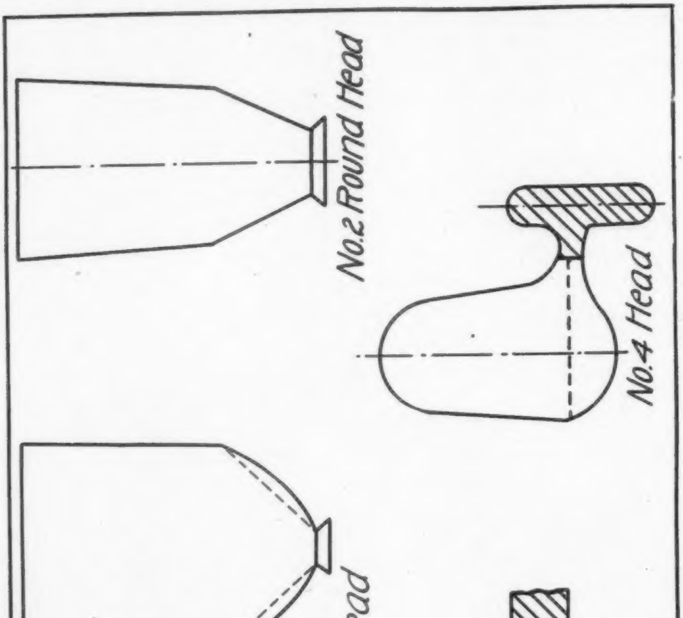

FIG. 1—DIAGRAMS SHOWING DIFFERENT TYPES OF HEADS

Fig. 1, or adjoining the heavy section as shown at No. 3, with a gate into a lighter part of the casting where the likelihood of shrinkage would not occur?

Chills Should Be Avoided

Also there are times when we have such designs that the shrinkage can best be taken care of by the use of chills. If it is possible to eliminate chills entirely, it is better practice to do so, as a shrink-head takes care of any possible void, while the chill simply drives the shrinkage to a part of the casting where it possibly may do no harm. The use of properly proportioned

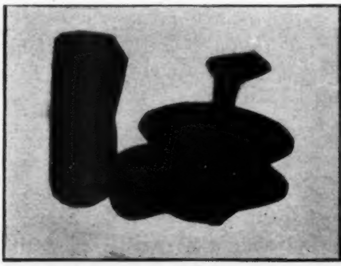

FIG. 2 — A MALLEABLE IRON SHEAVE-WHEEL OF IRREGULAR SECTION

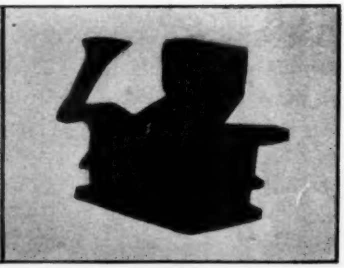

FIG. 3—SIDE-BEARING SHOWING HEAD USED TO ELIMINATE CHILLS

heads correctly located will yield much better results than can be obtained from chills, and while the remelt will be increased somewhat, nevertheless, satisfactory castings are secured, providing a correct mixture has been used. All shrinkage is absolutely eliminated and there is no fear of "too hot iron" when heads are substituted for chills.

After tentative plans for gating are settled and molding has been started, it sometimes happens that trouble again arises, in which event the foundry foreman must alter his arrangements. A miscalculation may have been made in the location of the gate, or again, it may have been too heavy at the entrance into the casting. Should the former be the case, then a study should be made of the best point to relocate the gate, having in mind the two suggestions made in a preceding paragraph.

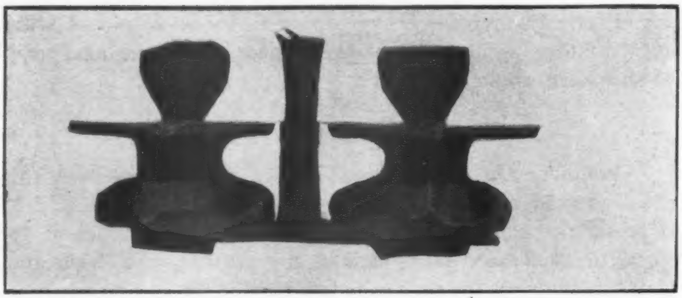

FIG. 4—HINGE-BUTTS WITH HEAVY HEADS

The malleable iron foundry is not unlike any other. It requires constant vigilance upon the part of the foremen of the various departments to cope with losses due to shrinkage and to prevent their exceeding a normal amount.

In cases where a large number of small patterns are gated together and you are endeavoring to make as large a mold as possible, due to the light weight of the castings, do not lose sight of the fact that it is important to cast each piece successfully. This is a point that always should be borne in mind. Frequently you hear it said, "This pattern always misruns or shrinks." If too many patterns are gated together, or if they are not arranged correctly, and some pieces misrun or shrink,

FIG. 5—BACK-STOP WITH A TROUBLESOME WEB

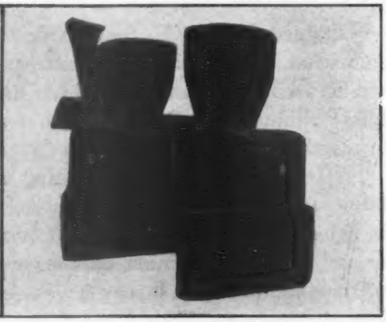

FIG. 6—CENTER-SILL SEPARATOR FROM WHICH CHILLS WERE ELIMINATED

stop and think out the best method of changing the gate or decreasing the number of patterns to overcome this trouble. Do not continue to make castings in this manner, with high foundry losses, accompanied by increased production cost on the one hand and hidden defects on the other, as it is not only a loss to your business, but a detriment to the malleable iron industry as a whole.

Cut Out the Shrinkage Defects

Should the castings contain shrinkage defects in cases where the engineer who made the design based his calculations on solid sections, he certainly would be disappointed, as he

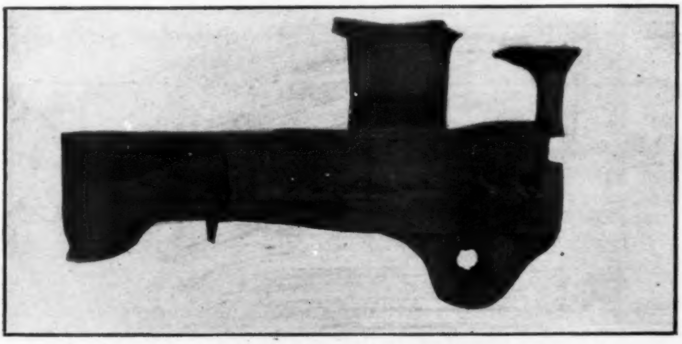

FIG. 7—COLUMN-POST GATED ON THE SIDE

would not secure the strength counted upon throughout the entire casting, and the piece might fail due to the existence of shrinks. It is essential that absolutely all shrinkage defects be eliminated. Failure to accomplish this end is many times the cause of a change from malleable iron to some other metal.

In order to give the reader a more comprehensive idea of the various methods of feeding castings, a number of diagrams, Fig. 1, are presented showing different designs for heads. A few illustrations of castings, with the gates and heads intact as they came from the sand, also are presented, no attempt being made to show anything special.

In locating a head to feed a casting adequately, it should be placed at a point where the weight of the metal will feed

down into the casting, as otherwise the head might rob the casting it was supposed to feed and thus cause shrinkage. In a case of this kind, the head usually should be placed over the heavy section and the gate located at a point where the section is more uniform. For instance, on a flat surface, the use of a design similar to No. 1 or No. 2, Fig. 1, should produce desired results. Should the design of a casting be similar to No. 3, which is a very unequal section, a head of the shape illustrated should feed the casting uniformly. The basin shown below the dotted line keeps the metal in the gate hot and fluid and prevents any possibility of chilling at this point, which would retard the feeding effect. Should we have a section similar to No. 4, Fig. 1, a feed-ball with a basin is satisfactory and in such cases proves very effective in eliminating shrinkage.

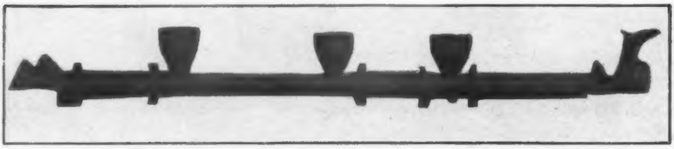

FIG. 8—CHEEK-PLATE WITH THREE FEEDING HEADS

Fig. 2 shows a very irregular sheave wheel casting, in which the sections are far from uniform. The rims are only ⅛-inch thick, the flange to which the head is attached, and the center of the casting range from 5/16 to ⅝-inch in thickness. The casting is gated over the center core with leads sufficiently large to admit the iron freely, yet keeping out the slag. The head in this particular casting is located at the bottom and feeds the casting thoroughly.

The sections in the side-bearing casting shown in Fig. 3 vary from 5/16 to ⅜-inch. There are a large number of angles giving excellent opportunities for shrinkage. Originally this shrinkage was taken care of by chills placed in the corners. These chills were eliminated when the head was substituted and an absolutely solid casting was the result. The head is so proportioned that the weight of the metal feeds down into the casting.

The hinge butt, shown in Fig. 4, is of ½-inch section except at the location of the gate, where it is approximately 1 inch. There is a round head located on each casting which feeds down through the center web, eliminating all shrinkage.

The back-stop shown in Fig. 5 is of ⅜-inch section throughout, with a centrally located web. The construction is such that the center web is pulling against the outside walls during

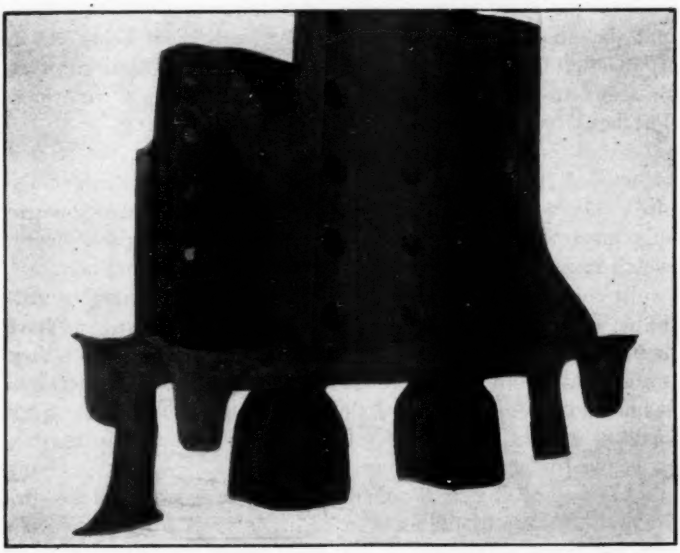

FIG. 9—HEAVY BOLSTER-CENTER FILLER CASTING WITH TWO HEADS

the cooling period. This unequal cooling is taken care of by the head shown in Fig. 5. This head has proven very effective.

In the center-sill separator shown in Fig. 6 the metal thicknesses vary from ½ to 1 inch. At one time this casting was made with chills located around the center web, the metal being poured from the same gate as now shown in the photograph. The shrinkage was completely removed in this casting

by changing from the use of chills to heads, with the elimination of all unsoundness.

The column-post, Fig. 7, is gated on the side opposite from that shown in the illustration with four leads into the mold. The head is located on the flat surface and successfully feeds the casting, eliminating all shrinkage.

The design of the cheek-plate shown in Fig. 8 is such that it requires three heads to feed it. Also chills are located in each of the three slots. Due to the dimensions of these slots and the necessity for the distance between them being exact, it was decided to mold these castings with dry sand cores in the slots to facilitate the manufacture and reduce variations. The heads feed the casting very successfully.

A bolster-center filler casting is shown in Fig. 9. It will be noticed that this casting is considerably above the average size. The feeding is taken care of by the two heads shown in this illustration. These heads pipe for a considerable depth, which makes it certain that the casting is fed sufficiently.

In conclusion, I might add that there are innumerable malleable iron castings that do not require such measures as have been illustrated in this paper to insure soundness, because their sections are both light and regular, which gives the metal an opportunity to set quickly, thus preventing shrinkage. Such castings can be made successfully by using the style of gate in vogue for many years.

Let me say that if the malleable iron founder will take care of his shrinkage by the location of heads so as to feed the casting wherever necessary, he can be sure of success in making heavy pieces with unequal sections. The practice greatly enlarges the field for malleable iron castings, and permits the engineer to design parts of much greater thickness than was believed possible in the past.

III

Gating Steel Castings

By W. J. Gilmore, East Chicago, Ind.

It is only during the past few years that the importance of proper gating has been realized by the majority of steel casting producers. In order to deal with the subject systematically, I will have to give some of the rules I personally have adopted to avoid the possibility of defective castings due to improper gating.

To cover the entire subject of various kinds of gating for all work would take a great deal more space than this paper will allow. The following data will therefore cover only my experience in gating while using the bottom pouring type of ladle. The defects and extra labor caused by improper gating are greater than from any other cause.

The first point to consider is the size and style gate to be used, that is, will the casting run with this particular size and style gate? Secondly, the place of gating should be considered. If gated at a certain point, will the casting check, scab, draw down or make a dirty casting? After due consideration of these points we must not overlook removing the gate from

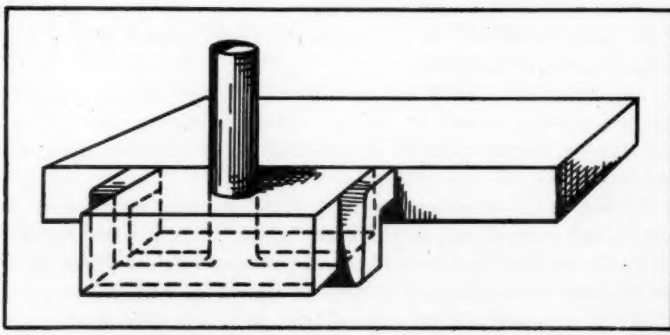

FIG. 1—CORE GATE SUITABLE FOR SMALL CASTINGS

the casting in the cleaning room. On all castings where it is possible to do so, I have found it advisable to use a bottom gate, also known as a fountain gate. This gate causes the metal to flow into the mold more easily on account of the corners it is forced to turn before entering the mold. Then, too, the area of the gate must be greater where joining the casting that at any other place to be assured of an easy flow into the mold. On castings where it is impossible to use a bottom gate, the core-gate, which answers the same purpose, is used.

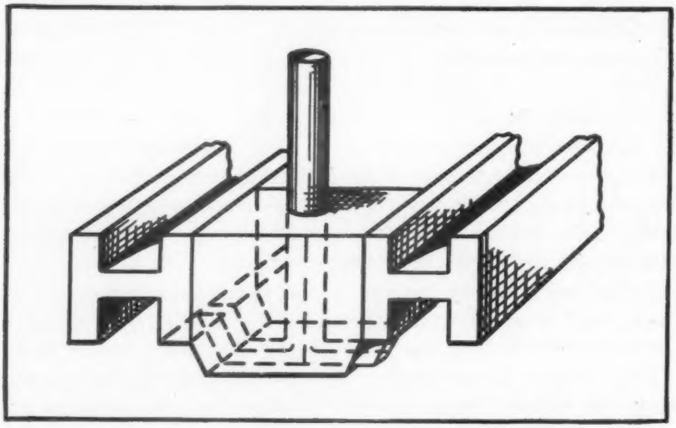

FIG. 2—CORE GATE SATISFACTORY AS A SUBSTITUTE FOR A BOTTOM GATE

This gate, which is just as practical as the bottom gate is on larger work, is shown in Fig. 1.

On matched work when rammed on jarring machines where too much time would be lost in cutting a bottom gate or by the use of a horn gate, it is practical to use a core gate, as shown in Fig. 2.

When it is necessary to make castings true to pattern a very good gate to use is the strain gate. This is very similar to the skim gate used extensively in iron foundries. This gate is attached to two center plates, as shown in Fig. 3.

It is customary in most foundries to use a fillet where the gate is attached to the casting. I think this is necessary on

large castings or castings with heavy sections. In foundries where miscellaneous floor work is made, the molders cut the fillets on the gates. The fillets are often cut too large, which allows the gate to break, leaving a large stub attached to the casting, which is difficult to remove. On small castings I do not think it necessary to use a fillet. If no fillet is used, the gates will be easily broken from the castings and also will break flush with the casting causing very little grinding.

To make good, clean steel rolls, we must use a gate that will cause the metal to swirl in the mold. This will keep all sand or dirt washed from gate in the center of the metal and

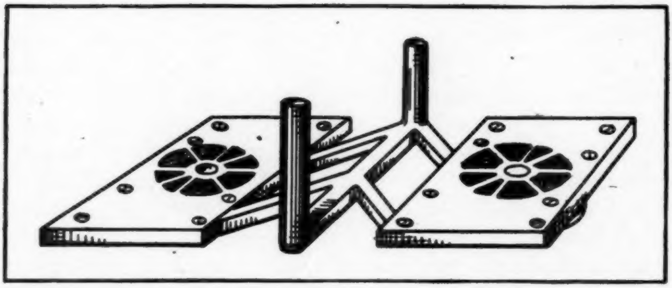

FIG. 3—STRAIN GATE USED WHERE CASTINGS MUST BE TRUE TO PATTERN

will carry it up into the head. In this case, we must have our down-gate of greater area than the gate running from the down-gate to the mold proper. The gate entering the mold must be set at the proper angle to make the metal to hit the walls of the mold upon entering, thus causing the metal to swirl.

Gates should never be covered with brick or scrap plate. Brick is not made of the proper material to withstand the molten steel without washing away. Scrap plate will chill the metal and, if rusty, will cause it to blow. Slab cores should be made of a proper size suitable for covering all styles of gates. We should always remember that more metal comes in contact with the walls of the gate than with any other part of the mold, and the metal is at a higher temperature when

passing through the gate than at any other time. Knowing this, we should protect the gate with the proper mixture of facing and also see that it is rammed correctly.

In my estimation, the subject of gating is as important as any one other feature connected with the production of castings. The proper gating of any casting usually calls for an individual decision as to what style of gate to use and in every foundry this problem should be made a matter for thorough study.

IV

Gating Non-Ferrous Metal Castings

By Russell R. Clarke, Pittsburgh

Good non-ferrous gating consists in the logical selection, construction, and placement of those circulating media by which metal either associates with its mold or exercises control over its casting product. Good gates, therefore, are instruments of control and media of transmission. This dual consideration is vital to gating results.

By trend of lead, gates admit a three-fold classification, those leading to, those leading from and those coursing independent of the mold. Briefly they might be termed, gates of ingress, gates of egress and gates of independent lead. Exercising widely different functions each type of gate thus classified must be studied and constructed accordingly.

The term *gate,* as commonly used, is broad and general, indicating part, parcel and whole of these instrumental media. Practice is common to designate all parts compositely—a gate—and just as prevalent to refer to each part separately as such. For distinguishing purpose individual terms such as ***sprue, head, riser,*** etc., frequently are applied, though the tendency is neither universal in scope nor uniform in term selection. Therefore, it is apparent that a well-defined and universally-accepted nomenclature of its gates has been one of the overlooked items of scientific effort along non-ferrous foundry lines.

Various Gates Defined

In the absence of such, and to avoid present confusion, this discussion will adhere to the general term and use qualifying words to designate the particular gate or part of gate referred to. By such method the following gates appear briefly defined:

Pouring Gate.—Vertical ingress gate descending the mold to the first abrupt change of direction and including a funnel-shaped top.

Pressure Gate.—Section of pouring gate above the highest point of the mold metal.

Drop Gate.—Vertical ingress gate used to *step* metal downward.

Button Gate.—Bowl-shaped basin underlying vertical gate to protect sand against the impact of the falling metal—a shock absorber.

Connecting Gate.—Horizontal gate joining the bottom of one vertical gate to the top of another.

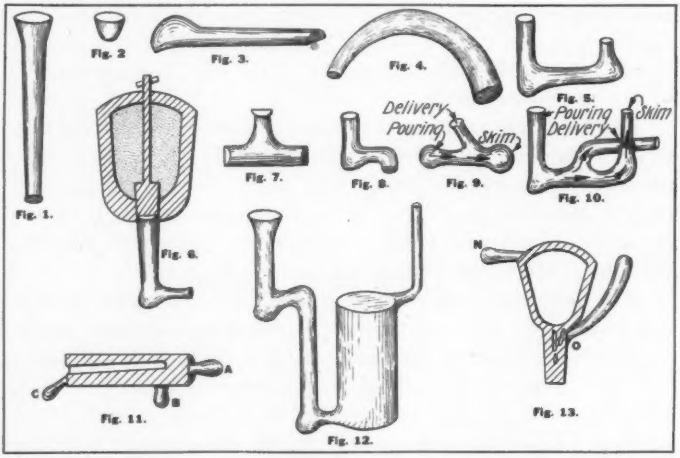

FIG. 1—POURING GATE. FIG. 2—BUTTON GATE. FIG. 3—RUNNER GATE. FIG. 4—HORN GATE. FIG. 5—U-GATE. FIG. 6—DROP-POURING GATE. FIG. 7—HORIZONTAL DELIVERY GATE. FIG. 8—CONNECTING GATE. FIG. 9—SKIM GATE. FIG. 10—SKIM GATE MADE BY A CORE. FIG. 11—*A* BURNS THE CORE END; *B* DISPLACES AND BURNS; *C* STRIKES AT AN ANGLE AND AT POINT OF MAXIMUM CORE SUPPORT. FIG. 12—A 6 x 14-INCH BRASS PIN, GATED AND POURED FROM THE BOTTOM. FIG. 13—*N* SUPERINDUCES A DRAW IN THE HEAVY LOWER SECTION WHICH THE HORN GATE AT *O* OVERCOMES

Delivery Gate.—Mold attaching ingress gate.

Runner Gate.—Main intermediate between vertical and delivery gates.

Riser Gate.—Vertical egress gate, functioned to pass off surface metal dross and relieve the mold of sudden applications of force generated by the pressure gate and intensified by momentum of metal.

Skim Gate.—Either egress or gate of independent lead,

mechanically constructed and positioned to trap dirt and dross and exempt mold metal therefrom.

Feed Gate.—Ingress gate, furnishing some part of the mold a higher temperature or greater bulk of metal than that reaching it through regular channels.

Horn Gate.—Gate resembling a horn. A sand hole delivery gate leading to some advantageous point in the mold not otherwise accessible.

U-Gate.—Modified form of horn gate realized through the use of dry sand cores and sub-surface in position.

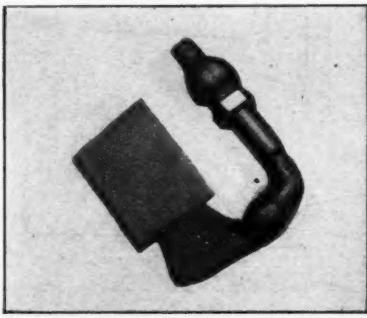

FIG. 14—EFFICIENCY OF DROP-POURING. A THIN DISC AND A HEAVY BODY RUN TOGETHER, PERFECT CASTINGS RESULTING THEREFROM

FIG. 15—THE LEAD PENCIL IS AS LOGICAL AS THE SAW LOG, THE CASTING BEING PERFECTLY SOLID

Drop-Pouring Gate.—Method of getting metal into a mold with maximum speed and cleanliness. The plan of enlarging gate head cavity to hold all metal required to fill mold and gates, fitting a stopper core in the bottom of the cavity, filling cavity with metal and suddenly lifting the core.

Bottom Gate.—Delivery gate attaching at or near the bottom of the mold.

Pop Gate.—Vertical gate attaching direct to the casting. Mainly illogical in non-ferrous practice.

Flow-Off Gate.—Egress gate permitting excess metal to course through a mold or some part of a mold for some specific purpose.

Overflow Gate.—One taking care of excess metal furnished by a flow-off gate that terminates in the atmosphere.

Representative of non-ferrous practice in general and conservatively responsive to their designating terms as noted, the foregoing gates will be thus referred to in this discussion, their implied sense, as briefly delineated, attaching.

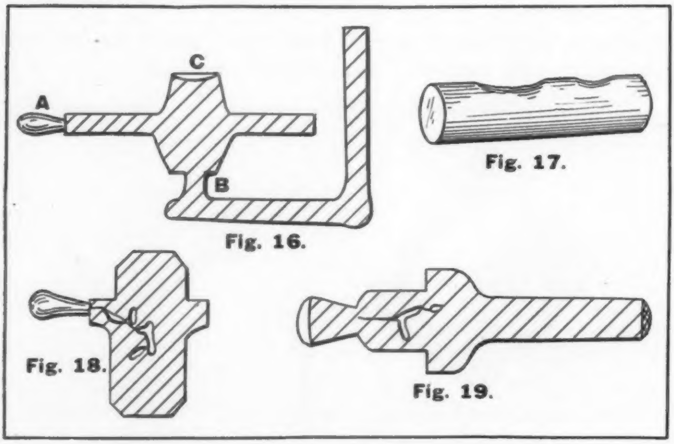

FIG. 16—*A* GIVES SHRINKAGE AT *C*, *B* PREVENTS IT. FIG. 17—A 3 x 12-INCH PIN, GATED AND POURED IN HORIZONTAL POSITION. END GATING AND POURING IS THE ONLY WAY. FIG. 18—CHUNKY CASTINGS, LARGE AND SMALL, REQUIRE GATES OF VOLUME. FIG. 19—VARIATION IN BULK HAS MUCH TO DO WITH LOCALIZED CONTRACTION. OPPOSITE ENDS OF SPINDLE IS PROPER GATE-ATTACHING VICINITY

Effect of Gating Practice on Casting Status

That a non-ferrous gate exercises a tremendous influence over its casting status, independent of its mere capacity to transmit metal, is a fact far removed from debatable grounds. Responsible to principle, that influence applies under all conditions of demand and wholly independent of class or type of work with fidelity to that principle. Operating on these broad bases, a gate can be so constructed as to menace any casting it will run. There is scarcely a class of non-ferrous work,

light, medium or heavy, in foundry practice today that cannot be gated to the scrap pile.

Nor does the proposition lack its practical and every-day foundry demonstration. Gate a 1½ x 12-inch round brass pin in the middle (longitudinally) and the highly probable result is a draw in the casting; transfer the same gate to the end and the chances favor a good casting. Gates too high, too low, too far, too close, too soft, too hard, too large, too small;

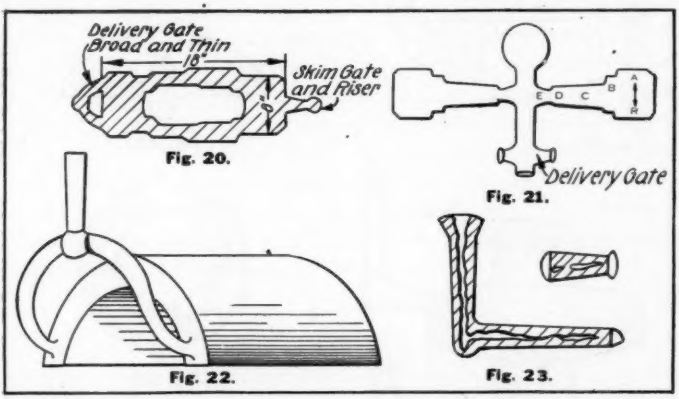

FIG. 20—METHOD OF GATING THIN WORK
FIG. 21—CORRECT FORM OF RUNNER AND DELIVERY GATE
FIG. 22—CORRECT PRACTICE IN DOUBLE GATING

FIG. 23—GATES PERMITTING SHRINKAGE CAVITIES TO RUN THE ENTIRE GATE LENGTH OR WHICH TERMINATE CLOSE TO THE CASTING ARE ALWAYS DANGEROUS

gates of illogical shape, volume, relation, placement and all, contribute more or less seriously to the defective casting evil in most all brass foundries of the day. From an experience covering ten years' inspection and examination into sources of casting defects, the author found at least 30 per cent of those sources identifying in some way or other with the gate.

An Impressive Example

A signally impressive example from experience follows: A foundry took an order for a large number of valve bodies under specifications on physical property covering a high pressure test;

88-10-2, manufactured from high-grade component elements, was the alloy decided on. The patterns were made and plate-

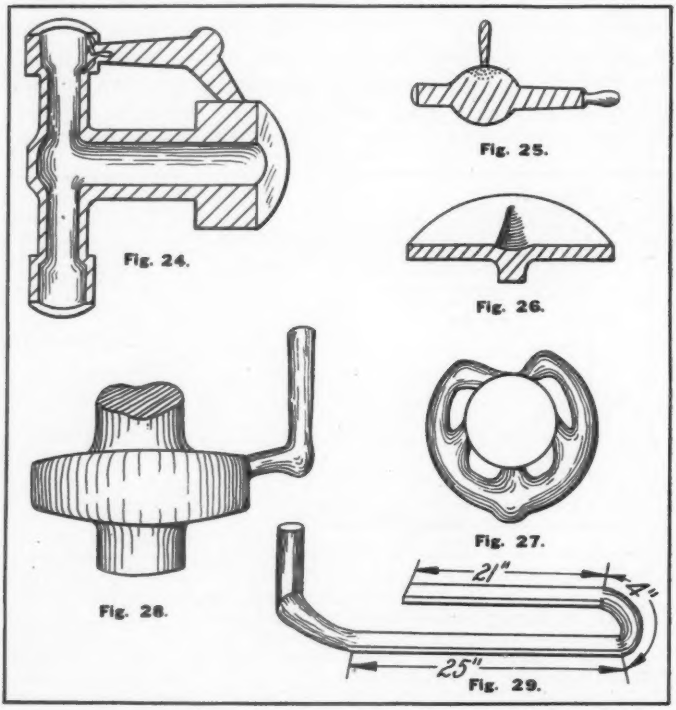

FIG. 24—A CONSEQUENCE OF DOUBLE GATING UNDER ILLOGICAL CONDITIONS

FIG. 25—EFFECT OF A DIRECT-ATTACHING RISER ON A COPPER-BASE CASTING

FIG. 26—EFFECT OF SLIGHTEST VARIATION IN BULK ON ALUMINUM

FIG. 27—GATE USED IN BOTTOM-GATING AND POURING THIN BUSHINGS

FIG. 28—A SHRUNKEN COPE—A MERE MATTER OF MORE PRESSURE

FIG. 29—POURED HORIZONTALLY AND WITH A SINGLE GATE, METAL RAN THROUGH A 1/8 x 1 1/8-INCH STRIP, STRAIGHT AHEAD, AROUND AND UP A TURN INCLINED AT 30 DEGREES AND BACK 21 INCHES. THE ALLOY WAS 85 COPPER, 5 LEAD, 5 TIN AND 5 ZINC

mounted for machine molding. The castings failed utterly under the test. Every related detail in practice was gone over

thoroughly and corrective measures instituted in all except the gating, to no substantial improvement. Finally, it was decided to alter the method of gating. The change had to do chiefly with delivery gate placement, and though necessitating the remounting of the plate realized its proof of wisdom in the minimum of subsequent casting failures under test, to which improvement it undoubtedly existed the main contributing factor. A further item of experience might challenge interest. The steam or forcing nozzle of a locomotive injector is a chunky, solid casting, weighing about three pounds and resembling a short section of tapering pin brass with a heavy knob on the heavy end, the heavy knob admitting a hexagon-shaped boss on the knob's extreme end. A mounted plate with gates attaching to the hexagon end produced castings with gate pin holes terminating in spacious cavities in the metal vitals of the knob. A smaller gate attached to the smaller end of the casting eliminated the difficulty and yielded perfectly clean and solid castings. It was all a matter of gating.

How, Where and Why to Gate

How and where to gate and why, are all significant items of brass foundry consideration. The connecting link between metal in the atmosphere and metal in a mold, between high temperature metal in its liquid and metal in its congealing and plastic state, it is at once apparent that the supreme function of a gate does not discharge with the delivery of its metal to the mold, that properly designed and judiciously placed, it is not a hap-hazard affair, but rather a scientific creation calling forth the most critical thought and skill of the craftsman. For in the finals of knowledge applied, it is the gate—not the furnace, nor the crucible, nor even the cavity of pattern impression—that is given us to adjust those decreed differences attending metal as it passes from its liquid to its solid state.

The principles of good gating practice derive their origin from related natural principles whose province they invade. These natural principles are those of hydrostatics, of expansion and contraction, of radiation and of gravity as affecting falling bodies. In the interests of more practical discussion, we shall examine each only insofar as it is practically applicable.

Hydrostatics observe three primary principles: Common level, pressure transmission and incompressibility. Briefly, the applied sense is that liquid metal of its own volition seeks common level in gate and mold, transmits free and undiminished its own weight—derived pressure and practically declines to compress under that, or any other pressure applied. By incompressibility, the metal in the mold is guaranteed full gate pressure. Calculation on that pressure, therefore, is an item of particularity, too little resulting in casting shrinkage, too great, superinducing mold swelling. Were liquids compressible, they would admit greater compactness, staging expansibility by pressure controlled, which would tend to neutralize contraction and make the gating of a casting a mere matter of calculating the pressure required to thus compress. A paradoxical feature of hydrostatics is that liquid columns of equal height generate the same pressure utterly independent of their volumes. Contraction and expansion are all but irresistible forces; they vary with volume, operate with different degrees of intensity on different elements and are most dangerous to casting status at or near the freezing point of the metal. Mainly, non-ferrous metals seldom localize contraction's effect executed on them in their solid state. Gravity has to do with velocity and momentum of falling metal, both of which increase with time of descent. In practice, it is concerned with drop-gate partition and the logical construction and placement of button gates.

Radiation is interested in either the simultaneous solidifying of gate vicinity in the casting and the gate, or the precedence of the former, the latter being preferred. It varies with volume and radiating surface.

Ignorance of Gating Principles

We shall not, we hope, be judged guilty of a sweeping accusation against average foundry intelligence when we conservatively estimate a great many molders sadly lacking in at least recognition and application of these basic principles. Nor do we presume to underrate the capacity for intelligence of those, who in actual ignorance of them, violate them, those who by the paradox of a thing narrow to the fallacy of a thing. Foundry apprenticeship and instruction have never been any

too strong in the enunciation of basic principle. It has been a rather mechanical piece of business, a business more of teaching a thing than the why of a thing; of expecting a man to follow a practice by merely observing a practice, to either dig up a principle for himself or allow that principle to lie undisturbed.

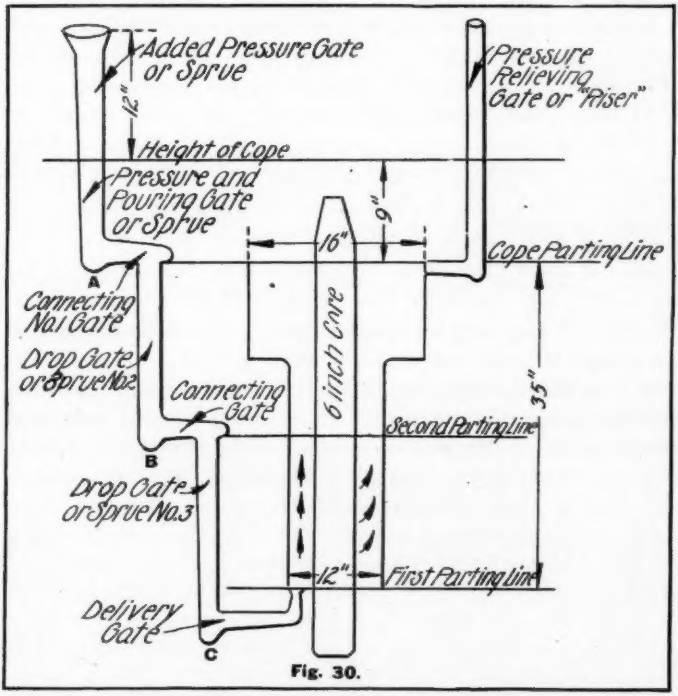

FIG. 30—THE USE OF PRESSURE, CONNECTING AND DROP GATES

A moment's reflection will readily expose the fact that each of the foregoing principles dominates a distinct form of physical activity, or, more correctly, natural force or tendency. It cannot fall far foul of lay observation also that these natural tendencies are so related in gate application as to act in conjunction with or opposition to both themselves and each other. Thus,

common level plus *pressure transmission* drives metal rapidly through gates and into their castings. Pressure suddenly applying to a filled mold strains the casting. That is an effect of gravity. A riser gate turns gravity against gravity, absorbs the shock and saves the casting.

In all matters of detail the whole philosophy of good gating consists in taking advantage of the situation, of establishing co-operation or opposition between one natural tendency and another. Opposition, being by far the most prevalent, it follows that mainly we must war on gating evils by inciting their producing causes to rebel against each other; nullify effects by neutralizing causes; in short, balance the thing up. Every non-ferrous casting run, yet ruined by its gates, represents an illogical order of precedence in these involved tendencies, the unwarranted ascendancy one is given over another.

Evils of Illogical, Non-Ferrous Gating

The primary evils of illogical gating are surface-evidenced shrinkage in cope and heavy metal vicinities; hidden weaknesses in casting vitals; pin holes at the gate and casting union leading to spacious inner cavities; drawing between light and heavy sections; exaggerated porosity; cold-shotted or mis-run castings; metal-dross pollution; partial or complete dislocation and breaking of cores; solid burning of cores and green sand mold vicinities; swelling of the casting; metal filling of core vents superinducing core blowing; localized vicinities of mold and metal dross in the casting; casting partition; occlusion of gases, etc. So manifold in detail are the causative sources of these consequences, that we pass them by in the interests of those considerations in which their remedies lie. These considerations cover four distinct phases of gating practice, as follows: General features, gate selection, gate form and volume and gate placement.

General Features

General molding skill and practice has much to do with the efficiency of a gate. The most trivial error of judgment therewith connected often will start something of serious

consequence. Best molding practice is always requisite to assured results. Gate-surrounding sand should be of sterling quality and in the very best condition. If too dry or weak in body, it will wash away; if too wet or strong, cutting with the same casting—impairment follows. Tamped too soft, its swelling deprives the casting of intended and requisite pressure; too hard, cutting and scabbing again appear. Liquids transmit shock as well as pressure, a *knocking* or boiling in the funnel of the pouring-gate is transmitted to the mold, superinducing unrest in menace to the casting. A leak between successive sections of an added pressure gate always involves a diminution of mold pressure. A purpose of the button gate is to absorb shock of impact from falling metal; to be logical it must be consistently soft, not only in the surface but gradually receding to its hard background of sand deeper down. Great volumes of metal in rapid transit through gates, play hard on naked sand surfaces. A coating of dry plumbago, well-rubbed in, is a great protection. Pouring and drop gates of great depths permit a metal momentum at their termini beyond green sand button-gate capacity to resist and the dry-sand-core button gate, therefore, must be resorted to. Connecting, runner and delivery gates, slanting upwards from source to terminus, break the force of flowing metal and in bottom gating and skim gate positioning are tributary to cleanliness of mold metal. The force of an inrushing current and its impact against the green sand core and pocket complement of a mold can be broken by a consistent turn in the horizontal direction of the delivery gate. Great complacency in current can be realized by *backing* the metal to a point away from the casting, thence into the casting. When conflicting conditions eliminate these precautionary measures, the situation often can be controlled by intercepting the force of the rushing current with a small dry sand core positioned at the point of impact in the mold. We have found this a most successful medium of relief to green sand cores of shallow bushings, rings, etc. These are but a few of the great mass of considerations involving common sense and headwork in gating and illustrate the difference, for instance, between

the molder lightly facing a cope with good sand and then filling in with any old sand, and the one seeing to it that every square inch of gate surface is amply backed with the very best of sand.

Gate Selection

Gate selection has to do with the type of gate used for different classes of work. In all cases the pattern should be carefully studied and the gate made to fit the occasion. Many a defective brass casting has explained thoroughly some inconsistency in choice of gate that the molder should have reasoned to before he laid its pattern on a follow-board. This business of first doing a thing and thinking about it afterwards is very bad practice in gating. The type of work has everything to do with the type of gate. The three most common types of delivery gates are the horizontal surface, the horn and the U-gate. The former applies to the common, ordinary classes of work to whose logical gating vicinity it is easily accessible, such as horizontally-cast bushings, valve bodies, stems, pin brass, etc. The horn and the U (virtually modified forms of each other) apply to gating vicinities beyond the horizontal surface gate to reach. Examples of their application are thin discs with heavy centers, tooth-cast gear wheels, heavy-bottom, light-top classes of work, and bottom-gating in the absence of flask parting along the gating plane. The flow-off applies to prolonged liquidity and circulation of metal in a mold as exemplified in silencing a blowing core or casting copper-base metal on iron, the feed gate attaches to high and heavy vicinities. Bottom-gating proves its advantage in the deeper molds whether heavy or medium and even in the lighter class of work such as bushings cast on end. The riser gate is necessary to molds of extensive cope area and all cases where extremely hard pouring is essential to results. The skim gate answers to the call for advanced metal cleanliness and the drop pouring gate takes up the task at the limit of skim gate capacity. The drop-pouring gate also will run a thin casting practically impossible to most of the other ordinary methods. An example of its running capacity and the absolute purity of its casting product is shown in Fig. 14, which illustrates the running of a thin

disc, 1/16-inch thick and 3 x 4½ inches, without the semblance of a flaw along with a valve body weighing some 4 pounds. In no part of the heaviest section and the highest point of the body was there the slightest intimation of metal impurity. The alloy used was half new, half scrap and very close to copper, 86 per cent; tin, 6 per cent; lead, 2 per cent, and zinc, 6 per cent.

Pressure Gates

The pressure and added pressure gates are necessary to a driving force and a holding power. They force non-ferrous metals into molds and hold them against mold-gas pressures and the recessions of contraction. Many a thin casting has tarried on its way to ruin pleading this driving force. As opposing shrinkage, the gate varies in height with bulk of metal, the metal's expanding and contracting tendency, its form in the mold and its degree of fluidity in pouring.

Form and Volume

Form and volume are most critical considerations. By the one the action of metal is controlled in the gates and its ratio of bulk to radiating surface determined; by the other, the evil of contraction in the casting is dominated. Surfaces of all gates should be uniformly smooth that maximum complacency in flowing metal be realized. The average alloy has a high specific gravity taking sternly to task the resistance of sand, and whatever in gate surface will prevent metal commotion is well worth considering. Metal in commotion disassociates and cools rapidly, thus subjecting the casting to an additional adverse influence. For heavy and medium-bulk work, ingress gates should represent maximum volume bounded by minimum surface. In all plane figures bounded by straight lines—polygons—those of equal dimensions—equilaterals—enclose greatest area within the same perimeters. Thus, a square 3 x 3 inches, contains one square inch more surface than a rectangle 2 x 4 inches, though the distance around both is the same. Since volume represents surface multiplied by the third dimension, it is quite evident that the equilateral type of any form of gate, whether triangular,

rectangular or whatever is the logical maximum-volume, minimum-surface selection.

The circumference of a circle is less than the perimeter of any polygon of equal area. Rationally, then, the bounding surface of the cylindrical gate is less than that of any other form of equal volume. Being true of the whole, it is true of the parts, and gives the semi-cylindrical form of gate the advantage over the triangular or any other form equal in volume and to the same purpose. To such forms we personally adhere most closely, and while molders may find it impractical to follow principles of construction to the letter, they can at least approximate them to advantage. In gating plate work for machine molding service, the plan can be faithfully followed to maximum of result in casting status and gate metal saved.

In the lighter and greater-surface classes of work, gate volume recedes in importance and form must alter to meet new conditions. No light or thin casting should be accorded runner and delivery gates much more bulky than the casting itself. These shallow transmitters, under proper pressure, keep compact bodies of metal in rapid transit. Our opinion is that misrunning of thin castings is more a consequence of partition and loitering than either low temperature or inherent tendency in metal.

Discussion of Gate Form

Gate form often menaces the welfare of the mold. To reduce the evil, horn gates should admit radii of curvature assuring a safe body of sand between their self-created openings and those portions of the mold they underlie. The same applies to U-gate dimensions. Button gates should represent cones diminishing downward and terminating in a circular basin. They should be cut on radii greater than the drop gate and positioned directly under it. At the immediate point of mold attachment, all gates should enlarge to fillet effect. Metal in ingress gates is hotter than that in the mold; that in egress is colder. It follows that in the same mold their forms must necessarily differ. Cooling in advance of mold metal and bereft of any substantial pressure, the egress gate must represent a minimum of contracting tendency to which reduced volume and

increased surface logically apply. The skim gate derives its efficiency from its mechanism and position. In those of independent lead, the principle is to intercept a stream of metal enroute to the mold, trap its dross into a by-path and permit the metal, thus clarified, to enter the casting. In mechanism, the gate varies with variation in idea of different practices. Very frequently the dry sand core is resorted to, admitting mechanism not practical to the green. Egress skim gates are usually parts of risers and pass off mold-accumulating dross. Positioned at highest points of mold or in vicinities to which ingress influence directs the mold current, and broad-cut to encompass sufficient mold surface, they promise best results.

Primary Evil of Contraction

The primary evil of contraction attending liquid to solid reduction is a draw or shrinkage cavity, bound to locate in either gate or casting. To keep it out of the casting is a chief end in gating. Tributary thereto is slight and gradual reduction from source to mouth in gate volume, and ample pressure. Every gate entering a mold should observe these principles of construction. It requires very little force of logic to convince that if a delivery gate at point of union with the casting is dimensioned to its volumetric requirements at that point and every linear unit back of that point slightly larger than at that point, there can be no natural chance of a congealing metal mass in the casting drawing on an empty source of supply and no principle—admitted possibility of congelation at any point in gate metal preceding that in the critical zone of the casting. The fact is that with maximum volume bounded by minimum surface, its diminution from source to mouth and a driving pressure behind it, we have three powerful influences conspiring to defeat the ends of contraction in the casting and against which that contraction cannot prevail unless aided by some external influence.

Gate Area at Point of Attachment

Gate area at point of attachment to the casting is highly critical. If excessive, every gate behind it wastes metal; if too small, it is incapacitated to its function, and shrinkage in the

casting results. Propriety must seek its promptings in conditions at hand and as affecting individual cases. Volume in the casting in relation to surface, fluidity of metal at correct pouring temperature, distance from gate entrance to extreme point of metal transmission in the mold, pattern variation in bulk, nature of metal used, and all must be taken into serious consideration. Bulky castings, large or small, require greater gate volume regardless of apparent insignificance; a 4-inch square disc, 2 inches thick, will get along better with the same gate volume than a 3-inch cube though the former represents 5 cubic inches more in solid contents. Gates as large or larger than the casting represent folly. The drop gate in Fig. 15 was made by an ordinary lead pencil and ran a 2-pound bulky casting perfectly clean and solid. By this the contention is not set up that lead pencils make appropriate drop gates, but rather that the lead pencil is as logical as the saw log. The instance in immediate question demonstrates the efficiency of logical gate construction, the power of the pressure gate and the advantage of a correct pouring temperature.

Gate Placement

Gate placement is another critical consideration. As in gate volume, everything depends on conditions. Generally, castings do better gated on the end than at middle points, the consideration finding application in bushings, stems, plugs, valve bodies, pin-brass, etc. A gate attaching to a heavy bulk, reducing backwards to a lighter, often produces pin holes and cavities in the heavier bulk. The heavy bulk being closer the gate out-liquidates both lighter section and gate, being drawn on by the former and derives no ultimate supply from the latter. Gating onto heavy sections connected with lighter ones presupposes a larger gate than the opposite. When bulk difference is not excessive, the better plan is to attach to the lighter section. In multiple gates attaching to light castings, position and current should be so determined as to lead streams to unite in the mold enroute through it. Unions of recoiling metal, or in streams of

metal approaching each other from opposite directions are, to say the least, well within the province of suspicion.

Bottom Method of Gating

Wherever admissible, the bottom method of gating is the ideal. Its advantages are manifold and plain. In both the heavy and the lighter classes of work, it will be found conducive to results. Possibilities in the latter are greater than lay judgment might suspect. For purely experimental purpose the author once got a perfect casting from a 1/8 x 1½-inch strip, 30 inches long, by pouring it in a vertical position and gating it at the bottom. In thin, cylindrical classes of work, our practice is to cast upright largely and to pour from the lowest position in the mold. The chime-whistle body is an example. In its pouring, metal winds in and around mold-congesting cores to a height of 14 inches running with fidelity very thin walls and webs, and a central bushing. Primarily, the advantages of bottom gating follow:

1—It makes the drop gate a skim gate.

2—It prevents disassociation of metal.

3—It graduates core gas formation and gives it free escape upwards.

4—It keeps vapor pressure ahead of the metal, and lessens its confinement in pouring.

5—It positions the delivery gate at the point of maximum pressure forcing a compact metal union.

6—It limits force and commotion of falling metal to a locality of licensed freedom in construction.

7—It sweeps everything ahead of it insuring surface position of mold-developing dross.

8—It generates greatest background vapor pressure in that vicinity of the mold where greatest metal pressure is present to resist it.

9—It practically eliminates shrinkage at the point of gate attachment.

Cases have been exceedingly rare where we ever found pin holes in bottom gates. Vapor pressure generated in the drop

gate sometimes sweeps the mold metal surface causing a casting top surface depression. Free venting and safe distance will overcome the difficulty.

Expansion and Contraction

Inherently differing in their capacities to respond to the volumetric changes of a ranging temperature, the different metals reveal little evidence of any general principle to which expansion and contraction admit responsibility. That heat expands and cold contracts, here a little and there a little more or less, is about the sum of general truth we possess concerning them. Alloys representing varying proportions of different elements involve a different degree of expansion and contraction and exact a similar consideration in their gating. Mainly, it appears that in casting, copper and aluminum are chiefly disturbed by these two opposite tendencies; that in combination they get little relief from it; that with the addition of lead and tin intensity recedes while in the presence of zinc it again jumps into prominence. A further observation is that whatever the immunity of new material to shrinking tendency that immunity becomes conspicuously absent with repeated remelting. To formulate a definite comparison of shrinking tendency between different elements and alloys in casting, a series of tests were roughly made. Dry sand molds were resorted to and a solid disc pattern, 4 inches in diameter and 1⅝ inches deep, was used. Semi-circular delivery and round pouring gates were selected, the pouring gate having been ¾ inch high and the delivery containing 7/20 of a cubic inch per linear inch. Half new and half scrap metal was melted in a small crucible, under best of practice, and the molds poured, with the results in shrinkage as indicated in the table on the following page.

Shrinkage Noted in Tests

Element or alloy	Maximum depression, inch	Position of depression	Surface affected sq. inches	Depression regular or irregular
Copper and small per cent of silicon	1/16	Central	10	Regular
Aluminum	1/16	Central	7	Regular
Zinc	3/32	Central	8	Regular
Tin	3/8	Beyond centre opposite gate	3	Regular
Lead	5/16	Centre	3	Regular
Cu. 90, Al. 10	5/64	Centre	6	Regular
Cu. 85, Pb. 5, Sn. 5, Zn. 5	1/16	Centre to outer edge opposite gate	5¼	Regular
Cu. 66 2/3, Zn. 33 1/3	3/16	Centre	9	Very irregular
Cu. 80, Sn. 10, Pb. 10	1/16	Opposite gate beyond centre line perpendicular to gate	3¾	Regular
Cu. 88, Sn. 10, Zn. 2	3/32	Centre	4½	Irregular

These results can be relied upon only in a comparative sense, for after all, the main evil of contraction in casting derives more from variation of bulk than from bulk itself. In the test, aluminum shrinkage did not show up so strong. As stated, dry sand molds yielded an advantage and in casting it must be considered that aluminum is, by virtue of its low specific gravity, a green-sand-abhoring metal. For this reason sand accommodating aluminum gates should be worked as dry and bodily impoverished as conditions will permit. Personally, so long as the sand doesn't fall out of the flask in manipulating, we feel satisfied. The flow-off and the pop gate work out to advantage in aluminum. The better form of pop gate is that of a common wedge, diminishing downward and attaching to the casting with a very thin edge.

Observations

Representing general conclusions as premised in the text and derived from that best of all teachers, *experience,* we close with the following observations:

A gate, not essential to it, has no business attaching to a nonferrous casting.

A button on a riser is a metal waster.

The smallest gate or set of gates conducive to casting quality, are the logical ones in non-ferrous work.

Smaller gates will answer for copper—tin—lead than those alloys including zinc along with them.

A gate's capacity to perform its function varies with the degree of fluidity of the metal in pouring.

Ingress gates are more critical in constructing than egress gates and in the main, are opposite in principle to them.

The volume of all gates tributary to it should be reckoned from the volume of the delivery gate at its point of union with the casting.

A good fillet will operate against a draw and will prevent the in-breaking of gates removed from hot castings.

Sharp angles at turning points of gates are not conducive to best results.

A good, gate-cutting molder can cut a better and cheaper gate in the sand for mounted plate work than a pattermaker can make a pattern for. The gate thus cut can be poured, finished and attached to the plate.

A form pressed into the sand to make a button gate is a *bone-head* play in molding.

Connecting gates cut above flask parting surfaces give better service than those cut below.

The top of a riser gate always should be covered in mold pouring.

Pressure is derived from height, independent of volume.

Pressure at any point in the mold equals height of gate above that point divided by 28 and multiplied by the specific gravity of metal involved.

Higher pressure is necessary for scrap than new material.

Touching-up a head gate aids feeding, but yields no additional intensity of pressure.

A leak in the gate reduces pressure in the mold.

Metal sinking rapidly in a pressure gate may indicate a swelling casting.

If the shrinkage cavity in a pouring gate descends to the gate's lowest point, its extension upward or increase in its volume is requisite.

Ratio of gate pressure to casting volume varies. A pressure gate, 21 inches high, produced a perfectly solid and unshrunken, solid disc weighing 1,000 pounds, poured with 2/3 new, 1/3 old 80-10-and-10 metal.

Correct pouring of a mold has a distinct bearing on the accomplishment of its gates.

Gate pin holes in the casting result from a variety of causes. Among them are hard ramming, wet sand, lack of pressure, improper construction or placement, double gating and cold metal.

All gates should observe a minimum in safe distance to or from the mold.

Green sand gate transmission of large volumes of metal finds additional safety in properly skin-dried gates.

Double gates of unequal volume, or those attaching to light and heavy casting sections respectively, superinduce shrinkage.

Pouring should be started in a feed gate the moment metal from the mold enters the same, otherwise the gate may freeze or its colder metal may be driven back into the casting, porosity resulting. The same applies to the double pouring of molds.

A green sand head or pressure gate yields best results in pouring chill-made, copper-base castings.

In the drop-pouring method, pressure applies most suddenly and should be intercepted by strength of mold with riser gate relief.

Molds containing delicately anchored cores should be so gated and poured that rising metal plays on the minimum of core surface. If, for instance, a vacuum cleaner, gate and pour it on its end.

A stream of metal playing throughout pouring on a given core surface, is liable to burn the core solid at the contact point.

A gate situated too close to the edge of the flask is a menace to the casting.

Killing two birds with one stone is a great stunt in gating. If a riser can be made to perform its own and skim-gate functions, take advantage of the situation.

The use of water in gates is bad practice.

Gating from one casting to another admits a chance of both being bad.

A single gate cut at such an angle as will direct the metal current to a circular motion in the mold answers best for ring-shaped castings.

Double gating superinduces drawing, sends two streams meeting at a point opposite the button gate, depositing all their dross at that point and often failing to unite properly.

Cope shrinkage usually is a consequence of cold metal and poverty of pressure. *Drawing* can follow the same, though it is just as likely to result from variation in bulk of metal. Both are consequential also to errors in molding practice.

Every pressure gate should slightly and uniformly overtax its mold-resisting power. I don't like an absolutely finless casting.

Heavy work delivery gates require that volume only that will satisfy the demands in the critical zone of the casting, which critical zone is the vicinity of gate attachment. It is folly to so *volume* all gates as to out-liquidate, in entity, their castings.

Elevating the pouring ends of molds of horizontal gating to aid in running the castings is a delusion. Metal runs to best casting advantage when driven either up-hill or on the level by ample pressure behind it. It runs down-hill better, but it doesn't always hang together in so doing.

Excessive hard tamping will stop a thin gate from running.

High temperature metal is most exacting on gates. Cold metal creates greater friction but forms its own protection by its surface congealation.

Logical order in relative position to the button gate has much to do with efficiency of gates attaching to loose pattern work. Hotter metal, and greater pressure in consequence, locates nearest the source of the gate.

Capacity to run a casting yields to direction forced on the metal by the gates. Very often a thin casting worked along with heavier work will do better at the extreme end of the runner gate than from a gate branching from the button gate, a matter of direct and rapid transit.

At their union therewith, the bottom surfaces of all delivery gates should approximate, though never exceed, the surface of the runner gate.

By sawing a trial gate in half and examining its inner condition, much valuable information, not otherwise evidenced, can be obtained on the true worth of the gate.

Delivery gates with pinholes leading up to the casting are weak, while a central cavity running longitudinally the entire length of the runner gate is evidence of illogical conditions somewhere regardless of casting appearance.

In all cases of the highly duplicated type in loose pattern work, by making sufficient patterns to fill a flask and a master gate for continuous service, great saving and efficiency can be realized.

Scientific gating makes dead-sure of everything happening in gate connection. Before putting them in service, all set gates should be thoroughly tried out and investigated, and the logic of theory thus checked against the infallible logic of results in practice.

Report of A. F. A. Committee on Specifications for Foundry Scrap

Until the appearance of the chemist in the foundry industry, it was generally believed that each class of work required a special grade of pig iron, determined by fracture, and foundrymen did not believe it possible to use any appreciable quantities of scrap in their mixtures. A little return scrap was melted, usually for castings that did not require machining. The use of steel scrap was not even considered. Some superintendents went so far as to have all nails, hoop-iron, etc., removed from their kindling wood, on the ground that it would seriously injure the quality of the castings.

Today all this is changed. Mixtures containing 50 per cent scrap are the rule, rather than the exception. Under certain conditions even as high as 80 per cent scrap may be employed and steel scrap is used freely in gray iron foundries.

Progress in Spite of Obstacles

This progress has been made in spite of the fact that foundrymen have been greatly handicapped by the want of suitable specifications governing the classification and purchase of scrap materials. Chaos rather than system has ruled and today scrap is the only material the foundryman purchases blindfolded.

It was for the purpose of remedying this condition that this committee was appointed at the Atlantic City convention last year to continue, and if possible conclude, the preliminary work of the 1914-1915 Committee on Specifications for Foundry Scrap. It is the hope of the committee that its suggested specifications are broad enough, yet sufficiently rigid to enable each foundryman to purchase scrap suited to his peculiar needs. At the same time, an effort has been made to draw up specifications that are fair to the dealer.

The committee realized it was going to be a difficult task to draw-up specifications that would meet all requirements.

Therefore, a circular letter of inquiry was sent to the 850 active members of the association requesting an expression of their ideas on the subject. Only about 50 replies were received, showing clearly how little thought is given to this important subject.

Among the answers, however, were a large number of suggestions of great value and the committee wishes to thank those who so kindly replied.

Many of the replies brought out differences of opinion that indicate the necessity for a large amount of educational work. For instance, one foundryman in New Jersey believes it sufficient to "purchase gray iron and steel scrap on personal inspection". On the other hand, another foundryman, in Massachusetts, prefers an elaborate series of specifications based on chemical analysis. This foundryman states in part, "For No. 1, I would want light mill machinery scrap that would run from 2.50 to 3.25 per cent silicon, 0.90 per cent in phosphorus, 0.80 per cent manganese and 3.90 per cent in total carbon. This with a No. 2X iron, with silicon 2.50 per cent, would make good light machine castings." He also says, "I think any foundryman can get any kind of a mixture with most any kind of scrap and good No. 2X pig iron, if he only knows what he wants. A good many men don't know what they want to get certain results and these men have to rely on the pig iron salesmen for their information. They, of course, tell them that they must use their irons with a good No. 1 scrap and mix 50-50."

A foundryman in Buffalo is afraid that "any additional grading would be likely to increase the cost of the material." Another, in Texas, thinks that "in a few years, when we begin to get semi-steel scrap, we will have to change our methods of mixing steel with our scrap, which," he anticipates, "will give us some headaches."

A foundryman in western New York wrote that there are only three classifications in general use in that vicinity, namely, stove plate, railroad and agricultural scrap. A Pacific coast foundryman wrote that specifications for scrap material could not be enforced in the far west, "due to the fact that very few

foundrymen make any particular classification which is descriptive of the material, and, therefore, it is not necessary for the scrap people to sort it very closely."

Classification Based on Metal Section

In the view of the committee, however, the keynote of the scrap classification problem was struck by a Philadelphia foundryman, who wrote, "In classifying cast iron scrap, our thought would be to grade it *with reference to the amount of silicon* (and other elements) *it is likely to contain.*" Such a result can be reached, in the opinion of the committee, only by arranging the sub-classifications according to metal section, rather than according to the weight of the piece. Foundry practice is so standardized today that castings of similar section, made for the same general purpose, have a common, definite chemical composition, within reasonable limits. Light machinery castings, for instance, with metal sections ½-inch or less, may be assumed to contain 2.25 to 2.75 per cent silicon; 0.08 to 0.10 per cent sulphur; 0.65 to 0.75 per cent phosphorus; 0.40 to 0.70 per cent manganese, and 3.25 to 3.50 per cent total carbon. Heavier scrap, of course, contains less silicon, and analyses assumed from the metal sections will be found to be sufficiently accurate for all practical purposes in figuring mixtures.

Malleable Specifications

The same general principles apply to malleable scrap, which accordingly has been classified on a basis of metal sections. On this point one malleable foundryman, in Indiana, wrote as follows: "We believe that malleable should be divided into two sub-classifications, of heavy and light material. Heavy castings would be five pounds or over with a section of ⅜-inch or over and light castings under five pounds with a section under ⅜-inch, but all castings with a ¼-inch section should be classified as light. We further believe that pipe fittings should be kept in a separate classification. Cupola malleable should be classified as such with the further sub-classification as above mentioned for regular or ordinary malleable scrap."

Further reference to this question is made in a letter from a New York manufacturer of harvesting machinery, who says: "We would suggest one class of light scrap which would include sections up to ¾-inch in thickness and two classes of heavy scrap, one class to contain all heavy scrap over ¾-inch in thickness and less than 24 inches in any dimension, the other to contain all over ¾ inch in thickness and greater than 24 inches in any dimension. We think it useless to make a special classification for cupola malleable, as it would be quite impossible for scrap collectors to determine which is cupola malleable, and as there is so little of this material, it would take them a very long time to collect any quantity of it."

Steel Scrap Specifications

Although fairly satisfactory specifications for steel scrap have been in use for a number of years, the committee found considerable difference of opinion among steel foundrymen. An Illinois foundryman believes that a classification, including short steel rails, knuckles and couplers, railroad steel and structural sheets, is sufficient. Other melters prefer more elaborate classifications. One steel foundryman in Michigan buys nothing but drop-forge crop-ends and drop-forge flashings. Converter and electric steel foundrymen point out the necessity of keeping the phosphorus under 0.04 or 0.05 per cent, at the same time specifying that the pieces be of such size as to permit easy charging in the cupola and electric furnace.

With the foregoing facts and opinions in mind, the committee prepared the specifications for gray iron, malleable and steel scrap presented herewith. They are submitted with the recommendation that they be adopted.

G. E. Jones, *Chairman.*
V. H. Meissner,
W. J. Nugent,
J. G. Garrard,
H. Cole Estep.

Specifications for Cast Iron, Malleable and Steel Scrap

CAST IRON SCRAP

No. 1 Machinery Scrap

This material shall consist of cast iron scrap of first quality which possesses evidence of having been machined, such as planed or turned surfaces, bored or drilled holes, etc. It must be cupola size, no piece to weigh more than 100 pounds, and must not exceed 24 inches in length or width. It shall be classified as follows:

No. 1 *Heavy,* pieces greater than 1 inch in section.

No. 1 *Medium,* pieces ½ inch and not to exceed 1 inch in section.

No. 1 *Light,* pieces not to exceed ½ inch in section.

Scrap classified as railroad cast scrap or under any other classification of these specifications, and burned iron of every description will not be accepted under the foregoing classifications.

No. 2 Machinery Scrap

This material shall consist of cast iron scrap of first quality which possesses evidences of having been machined, such as planed or turned surfaces, bored or drilled holes, etc. It shall be in the unbroken state. It shall be classified as follows:

No. 2 *Heavy,* pieces greater than 1 inch in section.

No. 2 *Medium,* pieces over ½ inch in section and not to exceed 1 inch.

No. 2 *Light,* pieces not to exceed ½ inch in section.

Scrap classified as railroad cast scrap or under any other classification of these specifications, and burned iron of every description will not be accepted under the foregoing classifications.

No. 3 Rough Scrap

This material shall consist of cast scrap such as columns, pipes, plates and rough castings of a miscellaneous nature broken to cupola size, pieces not to exceed 100 pounds in

weight and must not exceed 24 inches in length or width. It shall be classified as follows:

No. 3 *Heavy,* pieces greater than 1 inch in section.

No. 3 *Medium,* pieces over ½ inch and not to exceed 1 inch in section.

No. 3 *Light,* pieces not to exceed ½ inch in section.

Scrap classified as railroad cast scrap or under any other classification of these specifications, and burned iron of every description will not be accepted under the foregoing classifications.

No. 4 Rough Scrap

This material shall consist of cast scrap such as columns, pipes, plates and rough castings of a miscellaneous nature in the unbroken state. It shall be classified as follows:

No. 4 *Heavy,* pieces greater than 1 inch in section.

No. 4 *Medium,* pieces over ½ inch and not to exceed 1 inch in section.

No. 4 *Light,* pieces not to exceed ½ inch in section.

Scrap classified as railroad scrap or under any other classification of these specifications, and burned iron of every description will not be accepted under the foregoing classifications.

No. 5 Machinery Scrap

This material shall consist of burned machinery scrap of miscellaneous character, but must not include any burned material included in any other classification of these specifications.

No. 1 Stove Plate Scrap

This material shall consist of the best class of clean stove plate. It must be free from malleable iron and steel parts, grates, burnt iron and other miscellaneous scrap usually collected with this material.

Scrap classified as railroad scrap or under any other classification of these specifications, and burned iron of every description will not be accepted under this classification.

No. 2 Stove Plate Scrap

This classification includes all unburned cast iron stove parts not included in the No. 1 stove plate classification.

Scrap classified as railroad scrap or under any other classifi-

cation of these specifications, and burned iron of every description will not be accepted under this classification.

No. 3 Stove Plate Scrap

This material shall consist of burned stove parts of every description, but must not include any burned material included in any other classification of these specifications.

No. 1 Agricultural Scrap

This material shall consist of cast iron parts of agricultural machinery and shall be free from steel, malleable, chilled iron, such as plow points, etc., and burned iron of every description.

No. 2 Agricultural Scrap

This material shall consist of chilled iron parts of agricultural machinery and must be free from steel, malleable and burned iron of every description.

No. 1 Railroad Scrap

This material shall consist only of chilled cast iron car wheels conforming to the Master Car Builders' Association standards.

No. 2 Railroad Scrap

This material shall consist of miscellaneous cast iron car wheels not included in the No. 1 Classification.

No. 3 Railroad Scrap

This material shall include only plain gray iron brake shoes, which must be free from steel backs and inserts.

No. 4 Railroad Scrap

This material shall include steel back and insert brake shoes of both driver and car types. It shall not include brake shoes of the No. 3 classification.

No. 5 Railroad Scrap

This material shall consist of railroad burned iron of every description.

No. 6 Railroad Scrap

This classification includes unburned railroad grate bars and grate bar rests, and journal boxes with steel parts removed.

No. 1 Radiator Scrap

This material shall consist of radiator castings, broken, with all steel malleable and other parts removed. It must be free from scale and excessive rust or corrosion.

No. 2 Radiator Scrap

This material shall consist of radiator castings, not broken, with all steel, malleable and other parts removed. It must be free from scale and excessive rust or corrosion.

MALLEABLE CAST SCRAP

Only such scrap as has undergone the annealing process will be acceptable under the following classifications:

Automobile Malleable Scrap

This material shall consist of malleable cast iron parts of automobiles and must be free from steel forgings, stampings and gray iron parts. Railroad malleable, agricultural malleable and miscellaneous malleable, such as valves, flanges and pipe fittings, will not be accepted under this classification.

Railroad Malleable Scrap

This material shall consist of malleable iron parts of railway cars and other equipment. It shall be classified as follows:

No. 1 *Railroad Malleable,* pieces not exceeding ⅜ inch in section; also not exceeding 24 inches in length or width.

No. 2 *Railroad Malleable,* pieces not less than ⅜ inch and not greater than ¾ inch in section; also not exceeding 24 inches in length or width.

No. 3 *Railroad Malleable,* pieces greater than ¾ inch in section and exceeding 24 inches in length or width.

Agricultural malleable and miscellaneous malleable, such as valves, flanges and pipe fittings will not be accepted in this classification.

Agricultural Malleable Scrap

This material shall consist of malleable cast iron parts of agricultural machinery. It must be free from steel and cast iron. It shall be classified as follows:

No. 1 *Agricultural Malleable,* pieces not exceeding ⅜ inch in section; also not exceeding 24 inches in length or width.

No. 2 *Agricultural Malleable,* pieces not less than ⅜ inch in section and not exceeding ¾ inch; also not exceeding 24 inches in length or width.

No. 3 *Agricultural Malleable,* pieces greater than ¾ inch in section and exceeding 24 inches in length or width. Miscel-

laneous malleable such as valves, flanges and pipe fittings will not be accepted under this classification.

Miscellaneous Malleable Scrap

This material shall consist of valves, flanges and pipe fittings of every description and such malleable cast iron scrap as fails to conform to other classifications.

OPEN-HEARTH STEEL SCRAP

Heavy Open-Hearth Scrap

No. 1 *Heavy Structural Steel Scrap*—This material shall consist of all structural shapes, such as channels, angles, I-beams, plates, etc., ¼ inch in section and heavier. It must be of charging box size, not to exceed 5 feet long and 18 inches wide. No piece shall weigh less than 25 pounds. It must be free from iron of every description. This material must not include pieces that are covered with excessive rust or corrosion.

No. 2 *Heavy Structural Steel Scrap*—This material shall consist of all structural shapes ¼ inch in section and heavier, over 5 feet long and 18 inches wide. No piece shall exceed 600 pounds in weight. This material must be free from bent, curved and twisted pieces, and iron of every description. It must not include any material that is covered with excessive rust or corrosion.

No. 3 *Steel Rails*—This material shall consist of standard sections, 50 pounds and over, free from frogs, switches, guard rails and crossing rails. It must be of charging box size not over 5 feet long and 18 inches wide. It must not include any pieces that are covered with excessive rust or corrosion.

No. 4 *Steel Rails*—This material shall consist of standard sections under 50 pounds and free from frogs, switches, guard rails and crossing rails. It must be of charging box size not over 5 feet long and 18 inches wide. It must not include any pieces that are covered with excessive rust or corrosion.

No. 5 *Steel Rails*—This material shall consist of standard sections, 50 pounds and over, not cut to charging box size. It must be free from frogs, switches, guard rails and crossing

rails, and must not include any pieces that are covered with excessive rust or corrosion.

No. 6 Steel Rails—This material shall consist of standard sections under 50 pounds, not cut to charging box size. It must be free from frogs, switches, guard rails and crossing rails, and must not include any pieces that are covered with excessive rust or corrosion.

No. 7 Heavy Steel Scrap—This material shall consist of guard rails, switches, crossing rails, frogs, exclusive of iron plates, etc. It must be cut apart and be of charging box size, not to exceed 5 feet long and 18 inches wide, and must not include any pieces that are covered with excessive rust or corrosion.

No. 8 Heavy Steel Scrap—This material shall consist of frogs, guard rails, switches and crossing rails, not cut apart, over 5 feet long and 18 inches wide. It must be free from bent, curved and twisted pieces, and must not include any pieces that are covered with excessive rust or corrosion.

No. 9 Heavy Steel Scrap—This material shall consist of locomotive drivers, engine truck and coach tires, 36 inches and over inside diameter, and must be free from excessive rust or corrosion.

No. 10 Heavy Steel Scrap—This material shall consist of miscellaneous steel tires under 36 inches in diameter, and must be free from excessive rust or corrosion.

No. 11 Steel Tires—This material shall consist of steel tires as covered by classifications Nos. 9 and 10. It must be broken to charging box size, not over 5 feet long and 18 inches wide.

No. 12 Heavy Steel Scrap—This material shall consist of mild steel castings of a miscellaneous character. No piece shall weigh more than 300 pounds or less than 25 pounds. It must not contain malleable or cast iron and must be free from excessive rust or corrosion. It must not exceed charging box size, 5 feet long and 18 inches wide.

No. 13 Heavy Steel Scrap—This material shall consist of cast steel couplers, coupler heads, knuckles and draw bars. It must be free from iron yokes, etc., and must be free from excessive rust or corrosion.

Light Open-Hearth Scrap

No. 1 *Light Steel Scrap*—This material shall consist of steel springs, including all standard railroad coil and elliptical springs. No bar or coil springs under ⅜ inch in thickness or diameter will be accepted. The spring shall be free from plates. Elliptical springs must be cut apart. The material must be free from excessive rust or corrosion.

No. 2 *Light Steel Scrap*—This material shall consist of miscellaneous steel, such as plates, shapes, bars, structural crop ends, forging crop ends, fish plates, steel rail chairs, rail joints, etc. It must be limited to charging box size, not over 5 feet long and under 18 inches wide. It also must be under 25 pounds in weight, and must not include bundle scrap or iron of any description. It must be free from excessive rust and corrosion.

No. 3 *Light Steel Scrap*—This material shall consist of turnings, drillings and borings from wrought iron and mild steel. They must be clean and free from cast iron and malleable borings, brass, high-carbon steel borings and other metals. The material also must be clean and free from dirt and lumps, as well as from excessive rust or corrosion.

No. 4 *Light Steel Scrap*—This material shall consist of turnings, drillings and borings from high-carbon steel, such as tires and other similar material. This material must be clean and free from cast iron and malleable borings, brass and other metals. It also must be clean and free from dirt and lumps. It must be free from excessive rust or corrosion.

No. 5 *Light Steel Scrap*—This material shall consist of bundled scrap and all light steel scrap under ¼ inch in section, free from tinned and galvanized material. It must not be larger than charging box size, that is 5 feet long and under 18 inches wide. It also must be clean and free from excessive rust or corrosion.

No. 6 *Light Steel Scrap*—This material shall consist of miscellaneous cast steel not covered by other classifications. No piece shall weigh more than 25 or less than 5 pounds. It must be free from malleable, cast iron, etc., as well as be clean and free from excessive rust or corrosion.

CONVERTER STEEL SCRAP

No. 1 Converter Scrap—This material shall consist of mild open-hearth steel scrap, such as structural shapes, rolling mill crop ends, forgings and forge crop ends. No piece shall weigh more than 200 pounds or less than 25 pounds, and must not exceed 24 inches in length or width. The material must be free from excessive rust or corrosion.

No. 2 Converter Scrap—This material shall consist of open-hearth steel scrap, such as rails and high carbon, or hard steel scrap of a miscellaneous character. No piece shall weigh less than 25 pounds or more than 200 pounds, or be greater than 24 inches in length or width. The material must be free from excessive rust or corrosion.

No. 3 Converter Scrap—This material shall consist of miscellaneous mild steel castings. No piece shall weigh more than 200 pounds or less than 25 pounds. The material must not contain malleable or cast iron, must not exceed 24 inches in length or width, and must be free from excessive rust or corrosion.

No. 4 Converter Scrap—This material shall consist of miscellaneous mild steel castings. No piece shall weigh more than 25 pounds. The material must not contain malleable or cast iron, must not exceed 24 inches in length or width, and must be free from excessive rust or corrosion.

No. 5 Converter Scrap—This material shall consist of miscellaneous steel tires, broken. No piece shall exceed 24 inches in length or width. The material must be free from excessive rust or corrosion.

No. 6 Converter Scrap—This material shall consist of mild open-hearth steel scrap, such as punchings, shearings, forge flashings, forge crop ends, etc. No piece shall weigh more than 25 pounds or less than 5 pounds. The material must be clean and free from excessive rust or corrosion.

No. 7 Converter Scrap—This material shall consist of steel springs, including all railroad coil and elliptical springs, but no coil or bar springs shall be under ⅜ inch in thickness or diameter. They must be free from plates. Elliptical springs must be cut apart and must not exceed 24 inches in length, and the material must be free from excessive rust or corrosion.

CRUCIBLE STEEL SCRAP

No. 1 *Crucible Scrap*—This material shall consist of open-hearth steel punchings and must be free from shearings, clippings, tinned and galvanized material of every description. It must be clean and free from dirt and excessive rust or corrosion.

No. 2 *Crucible Scrap*—This material shall consist of mild open-hearth steel shearings, forgings, forge flashings and clippings. No piece shall exceed 5 inches wide or 8 inches long. It must be free from dirt, tinned and galvanized material of every description and free from excessive rust or corrosion.

No. 3 *Crucible Scrap*—This material shall consist of carbon tool steel, such as files, stub ends of carbon tools, carbon steel saw blades, wearing plates, etc. No piece shall exceed 5 inches wide or 8 inches long, and the material must be free from excessive rust and corrosion.

No. 4 *Crucible Scrap*—This material shall consist of steel springs of miscellaneous character, not exceeding 5 inches diameter or width and 8 inches long. It must be free from plates and other metals and free from excessive rust or corrosion.

No. 5 *Crucible Scrap*—This material shall consist of steel horse shoes, horse shoe nails, steel buckles, steel snaps, steel clamps, etc., and must be free from rubber, leather or other substances. It must be clean and free from excessive rust or corrosion.

No. 6 *Crucible Scrap*—This material shall consist of miscellaneous small soft steel castings, not exceeding 10 pounds in weight or 5 inches wide and 8 inches long. It must be free from malleable, cast iron or other metals, and also must be free from excessive rust or corrosion.

ELECTRIC FURNACE STEEL SCRAP

No. 1 *Electric Furnace Scrap*—This material shall consist of mild open-hearth steel punchings, but must not include shearings, clippings or other materials. It must be free from tinned and galvanized material of every description, and must also be clean and free from dirt and excessive rust or corrosion.

No. 2 *Electric Furnace Scrap*—This material shall consist of mild open-hearth steel, such as plates, shapes, structural crop

ends, shearings and miscellaneous materials of this character. It must be not less than ¼ inch in section. No piece shall exceed 12 inches wide and 24 inches long, or weigh less than 10 pounds or more than 200 pounds. The material must be free from excessive rust or corrosion. Bundle scrap and iron of every description will not be accepted.

No. 3 *Electric Furnace Scrap*—This material shall consist of mild open-hearth steel, such as rolling mill crop ends, forge crop ends, and forgings. No piece shall weigh less than 10 pounds or more than 200 pounds. The material must be free from excessive rust or corrosion.

No. 4 *Electric Furnace Scrap*—This material shall consist of miscellaneous steel tires, broken. No piece shall exceed 12 inches wide or 24 inches long, and the material must be free from excessive rust or corrosion.

No. 5 *Electric Furnace Scrap*—This material shall consist of high carbon open-hearth steel, such as rails, and high carbon or hard steel of miscellaneous character. No piece shall weigh less than 25 pounds or more than 200 pounds or exceed 12 inches wide or 24 inches long. The material must be free from excessive rust or corrosion.

No. 6 *Electric Furnace Scrap*—This material shall consist of mild open-hearth steel, such as plates, shapes, structural crop ends, shearings and clippings, under ¼ inch in section. No piece shall exceed 12 inches wide and 24 inches long. Bundle scrap will be excluded, and the material must be free from hoops, cotton ties, wire, etc., commonly known as busheling, together with tinned and galvanized material of every description. It also must be free from excessive rust or corrosion.

No. 7 *Electric Furnace Scrap*—This material shall consist of carbon tool steel of miscellaneous character, such as files, stub ends of tools, carbon tool steel rollers, wearing plates, etc. No piece shall exceed 12 inches wide or 24 inches long. The material must be free from other metals and excessive rust or corrosion.

No. 8 *Electric Furnace Scrap*—This material shall consist of steel springs, including all standard railroad coil and elliptical springs. No bar or coil springs shall be under ⅜ inch in thickness or diameter. The springs shall be free from plates

and other materials. Elliptical springs must be cut apart and not exceed 24 inches in length. This material must be free from excessive rust or corrosion.

No. 9 *Electric Furnace Scrap*—This material shall consist of coil and leaf or elliptical springs under ⅜ inch in thickness or diameter. The springs shall be free from plates and other material. Leaf or elliptical springs must be cut apart and not exceed 24 inches in length. This material must be free from excessive rust or corrosion.

No. 10 *Electric Furnace Scrap*—This material shall consist of heavy turnings from high carbon or hard steel. Open-hearth steel must be free from light and curly turnings. It must be clean and free from excessive rust and corrosion.

No. 11 *Electric Furnace Scrap*—This material shall consist of heavy turnings from mild or soft open-hearth steel, free from light and curly turnings. It must be free from excessive rust or corrosion.

Note—Material coming under all of the foregoing classifications for electric furnace steel scrap, when purchased for the acid process is limited to 0.04 per cent phosphorus and sulphur.

WEIGHTS

Net Tons

All scrap bought or sold under these specifications shall be handled only on a net ton basis, said ton to consist of 2,000 pounds.

Variations

Variations in weights shall be subject to the regulations of the authorized weighing association operating in the territory to which the material is delivered.

REJECTIONS

The purchaser reserves the right to reject any material failing to conform to these specifications.

In the event of a rejection, all demurrage charges and return freight shall be paid by the seller.

Discussion—Report of A. F. A. Committee on Specifications for Foundry Scrap

The Chairman, R. A. Bull.—Gentlemen, this is an important matter. This Association, as far as I know, is taking the initial step for establishing the proper classification for foundry scrap. It is evident to you all how diligently this Committee has worked. They have given this subject a great deal of thought and after thorough investigation they are bringing you the results. We would be glad to have some discussion on the various specifications suggested for adoption.

Dr. Richard Moldenke.—I would like to suggest that this report be adopted by the Association. I don't know whether it is really right to adopt it without it being thoroughly gone over by the Association, but I think if anything of that kind is necessary it might be further investigated by the Executive Board. I don't like to have snap judgment made on such an important subject, but it might be possible to authorize the Executive Board to investigate further.

The Chairman.—I was just wondering if it would not be a good plan, Doctor and Mr. Jones, to submit the specifications for gray and malleable iron and steel to their respective sessions, where the matters could be thoroughly discussed.

Mr. H. Cole Estep.—Is it not the established custom of the Association to adopt specifications of this character tentatively, subject to a letter ballot, which would give ample opportunity for consideration in the future?

The Chairman.—That has never been done by this Association, but it is done by the American Society for Testing Materials.

Mr. G. E. Jones.—I wish to make a further statement in this connection. After the Committee's work was practically concluded I made it my business to spend several days visiting

gray iron, steel and malleable shops in the vicinity of Chicago, and without exception their specifications for the purchase of scrap were even more rigid than we have made these specifications, but without exception they thought that specifications of this character would be acceptable, although some said they should be just a little more rigid. They thought the specification should be adopted by this Association at the present time, so that they would have something definite to work to. If you order a car of stove plate, you will get everything except what you ask for, the bulk of the material being burned gate bars of every description, with one or two stove plates just to identify it. Now, I have endeavored, and the Committee has worked hard to formulate specifications that would enable each foundry man to purchase a class of material that would more nearly serve his needs. You may say that the specifications are a little too elaborate, but I say no, and the Committee says no, simply for the reason that the metal industry is the foundation, it is the life of all commercial progress. Why shouldn't we tell the dealers what we want, and in no uncertain terms? The engineers specify what they want and they get it; they demand that the foundrymen produce the very best castings that can be produced; to do this, we must have the best material, and, of course, you all know it is necessary to use a certain amount of scrap, because it is cheaper than pig iron —in many instances better; we get better castings by using a certain percentage of scrap than by using all pig, and that being true, we must be able to purchase the material that will suit each class of casting. If a man makes a casting which must be machined he must use good material in the mixture, otherwise the casting may be defective and cause rejection. I think these specifications should be adopted.

Mr. B. D. Fuller.—I think this is a matter of considerable importance; anything that can be done to harness the scrap business in the right direction will be of benefit. All large users of scrap know that it is pretty difficult to get what they want. I know that in a good many cases I don't get what I expected when I made the bargain for the material. Now, we ought to have a standard method. We all know the troubles we have by using poor scrap. I have in mind one instance.

We got some scrap and put it in the cupola and it developed that those pieces had been burned and annealed and you really can't imagine what a time we had; it shut us down altogether, completely filling the wind boxes with a solid mass. I would be very glad if we could adopt some standard which would force the dealers to send us the scrap we specify.

Mr. H. Cole Estep.—I believe Dr. Moldenke made a motion, which I wish to second. I would suggest that we take some definite action at this meeting. I don't approve of dividing it up and going into it in the various sessions. This scrap proposition has been before the Association for at least two years, and probably longer, and we have had ample time to think about it. As Mr. Backert suggested in connection with the cost system, I believe the present time should see some action taken on this very important matter.

The Chairman.—As there has been a second to this motion to adopt these specifications, it might be pertinent at this time for Mr. Jones to advise you as to the disposition of the Association of Scrap Dealers on this proposition. I believe this Association was formed about six months ago.

Mr. G. E. Jones.—I have been away most of the time, so that I did not have the opportunity to visit or talk the matter over with as many of the scrap dealers as I would have liked to, but I had the pleasure of talking to two or three of the leading scrap men in Chicago and vicinity and also to one man who is influential in the organization. I submitted the specifications, permitted this one man to read them, and he said he did not see anything objectionable about them. This gentleman was from Indiana and he said he did not think it would burden the scrap dealers any more than under the present arrangement. If we adopt these specifications, we will have something tangible to work on. I think it would be a good plan to do as Mr. Estep said; take some action at this meeting. If we limit our action to discussion, we will have to continue for another year, as in the past, without a definite specification. I might say that several of the railroads sent us copies of their specifications and we have not made ours any more rigid than theirs. We have here a specification that will give every foundryman an opportunity to purchase material that he needs.

Mr. O. J. Abell.—I think that very little can be expected in the way of technical co-operation between the scrap dealers and the buyers, but I think we will have to look more to the railroads. If we can get them to adopt these specifications, we may be able to reach the point where the dealers will have to conform.

Mr. Fisher.—If we adopt this this year and find that it is radically wrong, we can very easily change it at the next meeting. That is the only way to test it out really to put it in operation.

Motion adopted.

Mr. G. E. Jones.—Gentlemen, I wish to thank you on behalf of the Committee which worked with me on this proposition, and I want to thank them because they certainly did do splendid work.

Report of the A. F. A. Committee on Safety and Sanitation

During the past year, your Committee on Safety and Sanitation held one meeting at Rochester, N. Y., which continued two days, Thursday and Friday, July 20 and 21. The safety code compiled at this meeting forms a part of this report. Seven of the eight members were in attendance and it is doubtful if a more representative body of men could be gathered for the discussion of this important subject than that which attended this meeting. Several of the local foundries were represented by the heads of their departments and their suggestions proved to be valuable and exceedingly helpful.

It is believed by the members of the committee that this safety code for foundries is the best that has ever been compiled and its adoption is earnestly recommended.

Victor T. Noonan, *Chairman,*
Industrial Commission of Ohio, Columbus, O.

F. H. Elam,
American Steel Foundries, Chicago.

George B. Koch,
Pennsylvania Railroad Co., Altoona, Pa.

E. B. Morgan,
Norton Co., Worcester, Mass.

Richard Moldenke,
Watchung, N. J.

Thomas J. Soults,
Sill Stove Works, Rochester; N. Y.

C. E. Pettibone,
Pickands, Mather & Co., Cleveland.

Ralph H. West, *Secretary,*
West Steel Casting Co., Cleveland.

Proposed American Foundrymen's Association Safety Code

Rule A—Definition

1.—A "foundry" shall mean a place where any metal, alloy or composition is melted and poured into molds for the making of castings.

Rule B.—Entrances

1.—The term "entrances" shall mean passages for common use provided for employes during working hours, between the foundry and open air.

2.—Entrances to foundries shall be protected by a covered vestibule or its equivalent, which shall be so constructed as to eliminate drafts and of such dimensions as to answer ordinary purposes, such as the passage of wheelbarrows, trucks and small industrial cars. This rule shall not apply to entrances used for railroad or industrial cars handled by locomotives or motors, or for traveling cranes, horse-drawn vehicles or automobiles; these entrances may remain open for such time as is necessary for the ingress and egress of such cars, trucks and cranes, horse-drawn vehicles or automobiles. No locomotive shall be permitted to remain inside the foundry during the loading or unloading of the cars.

Rule C.—Gangways

1.—The term "gangways" shall mean well defined passageways dividing the working floors of foundries, but not the spaces between molds.

2.—Gangways other than those for carrying molten metal shall be of sufficient width and properly illuminated to safely allow the passage of men and materials. They shall be kept free from obstruction at all times.

3.—Main gangways where metal is carried by hand or buggy shall be of sufficient width to allow the passage of two

ladles going in opposite directions, with an additional side clearance of six (6) inches.

4.—Main gangways for crane ladles shall be wide enough to allow a clearance of eighteen (18) inches on each side of the largest ladle used, except in such cases where ladles are carried with a clearance of at least six (6) feet above the floor.

Rule D.—Aisles

1.—Spaces between molds shall be divided into three classes, which shall be known as "hand-ladle" aisles, "buggy-ladle" aisles and "crane-ladle" aisles.

2.—Hand-ladle aisles—when a ladle is carried by one (1) man shall be of sufficient width to allow two (2) men to pass.

3.—Hand-ladle aisles—when ladles are carried by more than two (2) men—shall be wide enough to allow two (2) men to walk abreast, with an additional total clearance of six (6) inches.

4.—Buggy-ladle aisles shall be of sufficient width to accommodate the ladle with a clearance of six (6) inches on each side.

5.—Crane-ladle aisles—leading from the molds to gangway—shall be of sufficient width to permit the safe ingress and egress of employes and safe use of ladles.

6.—During the progress of casting, every gangway or aisle shall be kept entirely free from pools of water or obstruction of any nature. Every gangway where industrial tracks are used shall be constructed of a hard material of substantial character, and the top of the rails shall be flush with the floor.

Rule E.—Ventilation

Removal of Smoke, Steam, Gases and Dust

1.—Every foundry shall be so ventilated during working hours that smoke, gases, fumes or dust injurious to the health of employes shall, as far as practicable, be rendered harmless by means of natural circulation of air, or by ventilating hoods, fans or other effective devices.

2.—Where the operation of drying ladles causes fumes or gases within the foundry, ventilating hoods shall be provided to remove such fumes or gases.

3.—All ovens from which fumes or gases escape shall be provided with hoods of sufficient capacity to remove such fumes and gases.

4.—Foundries in which alloys containing zinc or aluminum are melted or poured shall have a minimum ceiling height of at least fourteen (14) feet. Every furnace shall be provided with ventilating apparatus to effectively remove all noxious fumes and gases. The ceiling of such foundries shall be at least six (6) feet above curb lines.

Rule F.—Lighting

1.—The light in every foundry shall be sufficient to provide safe entrance and exit of employes, and to carry on work safely during working hours.

2.—When natural light is insufficient to properly light the foundry, artificial light of sufficient power shall be provided.

3.—The continuous use of hand torches or other lamps that emit injurious smoke or gases is prohibited.

Rule G—Heating

1.—The temperature in every foundry shall be maintained at not less than fifty (50) degrees Fahrenheit during working hours in all sections where employes are regularly working.

2.—The use of open salamander stoves shall be prohibited.

Rule H.—Sanitation

Water Closets

1.—Water closets shall be provided in every foundry for each sex, according to the following table:

Number of Persons.	Number of Closets.	Ratio.
1 to 10	1	1 for 10
11 to 25	2	1 for 12½
26 to 60	3	1 for 16 2/3
61 to 80	4	1 for 20
81 to 125	5	1 for 25

For every unit of 45 or fractional part thereof in excess of 125 employes an additional water closet shall be provided. Where water and sewage facilities are not available, sanitary chemical closets may be used.

Rule I.—Urinals

1.—Urinals shall be provided in accordance with the following table:

Number of Persons.	Number of Urinals.	Ratio.
1 to 30	1	1 to 30
31 to 80	2	1 to 40
81 to 160	3	1 to 53 1/3

And thereafter an additional urinal to every eighty (80) employed. One individual urinal shall be considered equivalent to two (2) lineal feet of trough or slab urinals.

Rule J.—Washrooms

1.—Wash basins with faucets for hot and cold water shall be supplied according to the following table:

Number of Persons.	Number of Wash Basins.	Ratio.
1 to 8	1	1 for 8
9 to 16	2	1 for 8
17 to 30	3	1 for 10
31 to 45	4	1 for 11½
46 to 65	5	1 for 13

For each additional twenty-five (25) employes at least one additional wash basin shall be supplied. Twenty inches of enameled sink, or its equivalent in sanitary properties shall be considered the equal of one wash basin.

Rule K.—Shower Baths

1.—Shower baths shall be provided according to the following table:

Number of Persons.	Number of Showers.	Ratio.
1 to 50	1	1 for 50
51 to 100	2	1 for 50
100 to 200	3	1 for 66 2/3
200 to 400	4	1 for 100

For each additional two hundred (200) employes, one additional shower shall be supplied.

Rule L.—Lockers

1.—Individual metal lockers arranged for locking shall be provided for employes, and shall be placed in a space used exclusively for such purposes. This space may be located in the washroom, the drying room, or at convenient places in the molding room.

Rule M.—Drying Room

1.—Facilities shall be provided, either in connection with locker room, wash or toilet rooms for the sanitary drying of workmen's clothes.

Rule N.—General

1.—All the above sanitary provisions shall be conveniently located in a place accessible to and connected with the foundry so that entrance thereto can be had without exposure to the open air. General recommendations to be approved at end of code.

Rule O.—Drinking Fountains

1.—Drinking fountains shall be installed at convenient places, and the use of a common drinking cup prohibited.

Rule P.—Core Rooms

1.—All regulations pertaining to the foundry such as heating, lighting, ventilating and sanitation shall apply equally to the core room.

2.—When core ovens are located in the same room in which the cores are made, the temperature of that part of the room devoted to core making shall not exceed one hundred (100) degrees Fahrenheit.

3.—Separate working space shall be provided where females are engaged in the making of cores.

4.—No female employed in any core making room shall be permitted to handle cores having a temperature in excess of one hundred ten (110) degrees Fahrenheit.

Rule Q.—Cleaning and Finishing Operations

1.—All castings shall, where practicable, be cleaned or chipped in rooms separated from those used for other purposes; but where castings are cleaned or chipped in molding or casting room, there shall be provided suitable screens, partitions, or other effective means to protect employes against flying chips or excessive dust.

2.—When finishing rails or benches are used, these must be sufficiently far apart to allow the operatives to pass between them without being endangered by falling castings.

3.—All cleaning and finishing floors shall be cleaned and leveled at sufficient intervals to insure safe working conditions.

4.—When dry tumbling mills are used exhaust apparatus shall be installed and operated that will effectively draw off the dust created by the operation of such mills; or the mills shall be enclosed in reasonably dust-tight compartments while in operation.

5.—Where dry grinding, buffing or polishing floor stand machines are used, exhaust apparatus or its equivalent shall be installed and operated that will effectively remove the dust created by the operation of such machines. This rule shall not apply to floor or bench stands used especially for grinding.

6.—Where swing frame or portable buffing, grinding or polishing machines are used, screens shall be provided to protect adjacent workmen.

7.—All abrasive wheels shall be provided with protection hoods adapted to a proper presentation of the work and be mounted with compression blotters and with relieved flanges, at least one-half the diameter of the wheel.

8.—Sand-blasting by hand-operating apparatus shall be carried on in suitable sand-blast rooms. Sand or shot blast operatives shall be provided with suitable helmets or masks, respirators, approved safety goggles, gloves and leggings.

9.—All men engaged in the cleaning and finishing departments shall be provided with approved safety goggles.

10.—All tools shall be kept free from mushroomed heads and kept properly dressed.

11.—All chisel and hammer handles shall be properly fitted and provided with safety wedges.

12.—All electric arc welding shall be properly enclosed to prevent egress of light rays. Such enclosures shall be properly ventilated.

13.—The operatives shall be provided with improved masks, gloves and slow combustion aprons.

14.—The use of high explosives is absolutely prohibited on the foundry premises.

15.—The breaking of castings by the use of a drop inside the foundry during the general working hours is prohibited. When a drop is used for the breaking of castings or scrap outside of the foundry, a permanent shield of heavy planking or other protection shall be provided.

16.—Every employe in every foundry shall use the devices furnished for his protection by his employer where there is a hazard connected with his employment.

Rule R.—Equipment

1.—The floor beneath and immediately surrounding a cupola shall be kept free from collection of water.

2.—All pits or openings located in foundry floors shall be guarded by suitable covers or railings or by watchmen.

3.—All ladles pouring from the lip, of two thousand (2,000) pounds or over capacity, shall be equipped with a worm-geared device for tilting them.

4.—All crane, truck and trolley pouring ladles shall be so constructed that the center of gravity shall be below the trunnion, and shall be equipped with a dog to prevent it from overturning.

5.—All single shank hand ladles shall be provided with sheet metal guards.

6.—Where the crown plate of an upright crucible furnace is elevated above the surrounding floor in excess of twelve (12)

inches, the furnace shall be equipped with a platform having a standard rail; such platform shall be constructed of metal or other fireproof material, and shall extend along the fronts and sides of the furnace, flush with the crown plate, and shall be at least four (4) feet in width, and shall be clear of all obstructions during pouring time. If the platform is elevated above the floor in excess of twelve (12) inches the lowering from same of crucible containing molten metal shall be by mechanical means.

7.—When the combined weight of crucible, tongs and molten metal exceeds one hundred (100) pounds, it shall be removed from furnace by two men, or mechanical means, and deposited on the floor.

8.—Equipment used for the movement of materials by overhead cranes, such as sand buckets, shall be of substantial construction. When buckets have movable bails, safety locks or catches shall be provided, and the use of such locks must be enforced.

9.—Substantial cast steel handles shall be provided on grab buckets to afford safe means of pulling or prying apart the jaws in case the cylinders stick.

10.—All equipment such as sand mills, tumblers, etc., shall have gears, belts and all movable parts safely guarded.

11.—All gears, including trolley gears, couplings, keys, set screws and other movable parts shall be completely closed by guards, so constructed as to afford easy access for inspection and repairs. Guards shall be strong enough and properly attached to cranes to catch and prevent the falling of the parts which are guarded.

12.—Foot-walks extending the entire length of the crane bridge girders on the line shaft side shall be of substantial construction, rigidly braced to eliminate vibration, having standard railing and toe boards to prevent the falling of workmen and tools, and provide a safe and adequate means of travel about cranes.

13.—Crane cages shall be enclosed to a height of 3 feet 6 inches above floor with non-combustible material, where molten metal is carried by the crane, otherwise a standard railing and toe board is sufficient.

14.—Fenders shall be provided on all crane and carriage and trolley wheels. These fenders shall be of such shape that they will tend to push a man's hand, arm or leg away from the wheel.

15.—In all new construction clearances between crane-walks, cages, etc., and the building walls and roof-trusses shall be ample to insure the safety of crane-men and repairmen.

16.—Suitable electrical or mechanical brakes shall be provided to insure the safe movement of cranes and loads.

17.—All cranes shall be provided with a safety lock switch box so that the electric control of the crane can be locked in the off position during inspection and repairs.

18.—All overhead cranes shall be provided with good strong foot gongs to warn workmen of the passage of overhead loads.

19.—The practice of riding chain and crane loads shall be prohibited.

20.—The swinging or dangling of loose crane chains as the crane moves down the floor shall be prohibited. In case it is necessary to move the crane along the floor with the chains dangling, the ends must be guided by chainmen walking beneath.

21.—All jib cranes shall be mounted on substantial foundations, and securely anchored to the building. All gears and moving parts shall be guarded.

22.—All sling beams shall be securely suspended from jib crane hooks, and guards shall be installed on the hook to prevent the beams from jumping out of the hooks. Sling beams shall be so constructed that the slings cannot jump off the beam, and can be readily moved to accommodate different size flasks.

23.—Slings of all kinds shall be constructed of material of proper quality and sizes to insure at all times a safety factor of 10.

Rule S.—Inspection

1.—All ladles, ladle shanks, crucibles, crucible shanks, crucible tongs, yokes, skimmers, slag hoes, crane chains, cables, ropes and slings shall, prior to their use, be inspected in regard to

their safe condition by the men preparing and using such appliances.

2.—An inspection in regard to the safe condition of all hoisting apparatus and accessories shall be made at least once a month by a man designated by the employers for the purpose, and a record shall be kept of such inspection.

Rule T.—Employment of Females

1.—No female shall be employed in a foundry unless upon examination by a physician, it has been determined she is of normal health.

2.—No female employed in any foundry shall lift any object exceeding twenty-five (25) pounds in weight, unless she uses mechanical mean by which her physical effort is limited to exertion equivalent to that number of pounds.

Rule U.—General Regulations

1.—Regulations affecting industrial establishments generally in respect to the safeguarding of transmission machinery, miscellaneous machinery, elevators, stairways, platforms, chains and cranes, or relating to sanitary conveniences and first aid equipment, not included in this Safety Code, shall apply with equal force to foundries.

2.—When handling molten metal, employes shall wear leggings, Congress type shoes, and when possible, goggles.

Recommendations

The Committee makes the following recommendations which it deems most essential in successful accident-prevention work.

1.—All injuries must be promptly reported, no matter how trivial, to proper authorities.

2.—Special efforts shall be made to impress upon all men the necessity of immediately taking care of all minor injuries, cuts, scratches and burns.

3.—It is recommended that tincture of iodine, and not peroxide shall be used for first aid purposes.

4.—Employes must not, under any circumstances, attempt to remove foreign particles from the eyes of a fellow workman; as infection is almost certain to follow the use of toothpicks, matches, fingers or handkerchiefs for this purpose.

5.—All eye injuries shall be attended to by a regular physician.

6.—The use of liquor shall absolutely be prohibited during working hours. Its use shall be discouraged at all times.

7.—Accident prevention will be encouraged by the formation of safety committees among the men. All foremen must take a personal interest in accident prevention and are expected to set an example of carefulness.

8.—Strict enforcement of workshop regulations is one of the best methods of accident prevention.

9.—First aid kits should contain—

A.—Package done up in waxed paper containing aseptic dressing and a bandage for some safe and effective antiseptic, such, for example, as a small vial holding 1 dram of 3 per cent solution of tincture of iodine, together with a camel hair brush and a bandage.

B.—Splints and roll of large bandages.

C.—Tourniquet.

10.—It has been proved that 75 per cent of all accidents can be eliminated by educational methods; therefore, the use of bulletin boards, motion pictures, safety meetings and suggestion boxes are to be encouraged.

11.—A room shall be provided and kept in a sanitary condition for the employes' use to eat their meals.

Discussion

Mr. V. T. Noonan.—I presume that all of you have a copy of the printed report of the Safety Committee. This report has been very carefully prepared and finally, at the last moment, some modifications were made. I want to impress upon all the members of the American Foundrymen's Association that

your Safety Committee, in preparing these proposed regulations, was most particular to keep the small foundry manufacturer in view.

The basis for the report which we are making to you today was the new Ohio foundry code. That code was made by a committee of practical foundrymen representing both the employers and molders. The late Thomas D. West, president of the West Steel Casting Co., Cleveland, and one of the best-known foundry authorities in the country, was the chairman of the Ohio Foundry Committee. That code has now been completed and I can say that the Industrial Commission of Ohio is going to use the very best judgment in regard to its enforcement. At present it is not going to be enforced as a state law, but rather as general standards for foundries, which have been requested to comply with it.

Similar codes have been prepared in New York and Pennsylvania and there is no doubt that other states in the country where there are foundries are going to pass similar legislation.

The American Foundrymen's Association has taken a very aggressive step in anticipating any such legislation.

It is unusual for a state official like myself to be chairman of a committee such as yours, but I feel that I am not a state official in the ordinary sense of the word—nor am I a politician. I have been trained in the business methods of a large corporation and am serving the state because of my experience. I want you to feel that in the work that has been done by this committee that I have not viewed it from the point of view of a state official, but rather, as far as possible, from your point of view.

I believe that the code which your Committee has just completed is one of the best in the country, and I think that in some respects it is superior to our Ohio code.

You notice at the end of the report that we have made some important suggestions. One of these is the necessity of enforcing shop discipline. I should say that 50 per cent of all accidents in the industries are caused either because working regulations are not obeyed or because there is laxity in enforcing shop regulations. I want to impress upon you that if you employers will enforce your working regulations, that if you

will try to have your men co-operate with you in obeying such rules, your accidents would soon be very much reduced.

It is important, too, that you keep your plants in a tidy and orderly condition. In Ohio we have found that falling objects have caused the largest number of deaths and the greatest number of permanent disabilities. Our next class of serious accidents were those caused by falls, caused by defective floors, slippery floors, holes in the floors, obstructions on the floors and aisles, poorly lighted workshops and stairways, defective stairways, etc.

Your Committee has also made a recommendation that workmen should not be permitted to put their fingers into each other's eyes to remove particles. Many eyes are lost because of this common and dangerous practice.

Your Committee has also emphasized the necessity of prompt first aid treatment for cuts, scratches and all minor injuries.

You cannot stop accidents purely by state legislation or shop regulations. You must educate your men. You must get close to them, and I feel that if many of you employers would endeavor to get in closer personal touch with your men, you would have less difficulty in preventing accidents in your plants.

I want to congratulate the American Foundrymen's Association for the broad, progressive step your Committee has taken in making its code. I will be candid with you, gentlemen. I was afraid that the members of your Committee would not be broad when it came to preparing these regulations and at our first meeting I decided that I would keep myself in the background to see what the other members would do. I was afraid they would not provide much that the molders are demanding today, and your Committee has surprised me with the splendid and generous spirit they have shown in connection with the work that has been done. In fact, I have never worked with a committee in which the members were better qualified to serve. Your Committee was appointed rather late and I feel that it should be permitted to serve another year, whether I am with it or not. I have regarded it as a great honor to be Chairman of your Committee.

In the recommendations that have been made in the report, I want to say that you can never go wrong by treating the other fellow fairly and honestly, and this seems to have always been the policy of the American Foundrymen's Association—to deal fairly and squarely and honestly with the vast army of molders that are employed in the foundries throughout the country. I ask you to receive this report in the same spirit in which it was prepared—honestly and openly. I feel that if you will adopt it, that it will bring greater renown and credit to your Association.

Finally, I want to thank President Bull and the Association in general for the honor conferred on me of being chairman of this Committee.

THE CHAIRMAN, R. A. BULL.—I will ask the secretary to read the written discussion by Mr. M. W. Alexander.

MR. M. W. ALEXANDER.—It is needless to say that my interest in a good foundry safety code is genuine and for this reasons I feel justified in speaking with utmost frankness, even though in doing so I may appear as a rather severe critic.

The proposed A. F. A. Safety Code has borrowed, as is proper, some sections from the Proposed Safety Code of the National Founders' Association, some from the New York or Pennsylvania Code already in existence, and has added some new sections. It is evidently the belief of your Committee that the best results can be obtained by combining what they believe to be good features in existing codes with additional information.

In taking up the principal sections of the Proposed A. F. A. Safety Code, I beg to offer the following criticisms and suggestions:

Section 1.—As written, this section permits of two interpretations; either it refers to the place generally in which metals are melted and poured into molds for the making of castings, and in this sense would cover the whole plant of which the foundry so-called may form only a part; or it has the narrower meaning in strict accordance with the language and would then not cover any molding rooms in which no metal is poured, any coremaking or cleaning rooms. This section should be made very clear as to its meaning.

Section 3.—No vestibule or its equivalent can *eliminate* drafts as stated in this section. Evidently it is meant to prevent drafts harmful to employes working within the foundry; and if it is so meant, it should be so stated. The last sentence, "No locomotive shall be permitted to remain inside the foundry during the loading or unloading of the cars," does not belong in this section which deals with entrances, but if it is to be stated at all, it should be stated with the sections dealing with ventilation. In this connection, it should be carefully considered that some foundries use locomotive cranes which have to remain inside the foundry during the loading or unloading of the cars, for that is one of their purposes. To replace such perfectly good equipment by traveling cranes would not only be an unnecessary hardship upon the foundry owner, but would also offer other practical difficulties.

Section 5.—This section states that gangways shall be kept free from obstruction at all times. This is an obviously wrong provision, for it is common foundry practice to shake-out the molds at night or after working hours in the gangways, and to place castings there until they can be removed by industrial cars or otherwise. It is often also necessary during working hours to use a part of the gangway temporarily for the placing of patterns, flasks, etc.

Section 6.—As this section is worded, main gangways, which of course must mean all gangways since there is no specific definition for main gangways, must be of a minimum width which it would be impracticable and useless to maintain in brass foundries, in small iron foundries, and particularly those already in existence, where every square foot of floor space possible must be utilized for production. An inspector would be justified in interpreting this section to require an aisle of at least eight feet of width to permit two men to pass each other with single hand ladles, each carrying his ladle in the usual position. Where molds are poured only on one side of the gangway, this would be an obviously unnecessary provision, but even where molds are poured on both sides of the gangway, a considerably smaller width is entirely sufficient for the safety of the employes, except where the gangways are very long and a large number of men pass in both directions. It is common

practice for the man with the empty ladle to step out between molds, or in any event to swing out his empty ladle over the molds as he passes the man carrying the full ladle.

The provision of Section 6 appears so much the more harsh when it relates to brass foundries, for then, with few exceptions, only one crucible is handled at one time in any gangway, and often in a whole brass foundry.

The foregoing criticism is predicated on the belief that where the section says "to allow the passage of two ladles going in opposite directions", it is meant the passage of two persons carrying ladles going in opposite directions. Would it not be best to state in feet and inches the minimum width allowable for gangways, and should it not be defined also that by the width of a gangway is meant the clear distance between molds, poles, partitions or other obstructions on one side of the gangway and similar objects on the opposite side?

Section 7.—In many steel and iron foundries very large crane ladles are used, some of them having a total of eight feet, and with the proposed clearance of 18 inches on each side, the gangways in such foundries would have to be at least 11 feet wide, which, of course, is an entirely unnecessary provision. Such crane ladles are usually moved over the molds and only lowered over certain molds for pouring by the bottom-pour method, or lowered in certain places for emptying by the tilting process. In any event, why should the width of a gangway, which is to be used for men walking through it, be related at all to the width of crane ladles that are not along gangways?

It seems that a much more definite and detailed provision for widths of gangways is needed to take into account not only the different ladles carried through the gangways and the different methods of pouring employed, but also the different types and sizes of foundries affected.

Section 9.—This section provides that when a hand ladle is carried by one man, the aisle shall be of sufficient width to allow two men to pass. Why should two men in addition to the one who carries the ladle pass the narrow aisle between molds? If any allowance is to be made for such a possibility, then I fear the productive space of many foundries, and par-

ticularly stove foundries, would be so reduced as to make it unprofitable to continue the foundry business.

Section 10-11.—Both these sections should be made clearer in their meaning.

Section 12.—What is the aisle leading from a crane to a gangway? The whole section needs careful rewording.

Section 27.—This section makes it mandatory for every foundry to furnish metal lockers for their employes. This provision should not be made so stringent, for some foundries provide spacious, well-ventilated clothing rooms in charge of responsible attendants, where the employes' clothing is much better cared for than if it was crammed into metal lockers, especially when such clothing is damp.

Section 41.—Is it necessary to insist upon safety flanges when the wheels are already sufficiently guarded by adequate protective hoods?

Section 43.—Why should all men engaged in the cleaning and finishing departments be provided with safety goggles? Men operating properly enclosed and ventilated tumbling in mills in cleaning rooms certainly do not need safety goggles.

Section 44.—Of course, tools cannot be kept free from mushroomed heads. The meaning of the provision evidently is that then the mushrooming proceeds to the point of danger, then such tool heads should be re-shaped.

Section 48.—It would seem impracticable to absolutely forbid the use of high explosives on the foundry premises. Suppose a concrete foundation in a foundry or a rock in the ground has to be removed, how else can it be done well except by the use of high explosives? The section should provide that high explosives shall not be used during regular working hours, and when they are used, adequate means should be taken to protect persons nearby.

Section 53.—This section provides that all ladles poured from the lip shall be provided with a worm-gear device for tilting the same. Evidently this is not meant, for most ladles are poured from the lip.

I have only attempted to point out some of the most glaring defects of the Proposed A. F. A. Safety Code. Many sections,

not herein specifically mentioned need re-writing in order to make their meaning clear.

As for the concluding recommendations of the A. F. A. Safety Code, I cannot agree that "employes must not under any circumstances attempt to remove foreign particles from the eyes of a fellow workman, and that all eye injuries shall be attended to by a regular physician." Sometimes there is only a speck of dust in a workman's eye, which can be readily and without the slightest chance for harm, be removed by a fellow workman with his own handkerchief or similar means, that it would be impracticable to require that the man go to a regular physician. Moreover, slight eye injuries can be attended to by a trained nurse or a properly instructed person, and cannot all be referred to a regular physician when, as in all smaller foundries, no regular physician is attached to the establishment.

In the recommendations for the makeup for first-aid kits, I notice that one of the very useful and necessary medicaments in the foundry, namely, burn ointment, is entirely omitted.

Lastly, why should a convenient, sanitary room be provided for the employes' use, in which to eat their meals, when perhaps only one or two employes in a given foundry may want to eat their meals on the premises? Such a provision has justification in connection with foundries in which zinc-bearing metals are melted, but is not necessary from a safety standpoint in respect to iron and steel foundries.

As I stated in the beginning, I have expressed myself rather frankly and without any attempt, on account of the very short time at my disposal, to couch the criticisms in particularly nice language. I am sure you will understand that my only desire is to have your Association, or any other Association or body, issue a safety code that is practicable in its provisions, clear in its language and justified to be imposed on all foundry owners, hence the above stated criticisms. I want to make it clear also that the suggestions above offered are not merely my personal viewpoint, but are the consensus of several hundred practical foundrymen, many of whom are A. F. A. members, and with whom the whole subject was thoroughly discussed in the preparation of the Proposed Safety Code of the National

Founders Association, and the Proposed Safety Code for the State of Massachusetts.

The proposed code will serve its purpose if it brings out a free expression of opinion from various members. I trust, however, that the code will be referred back to the Committee for further consideration and revision.

The numerous changes and revisions in the original draft of the Safety Code presented by the A. F. A. Committee are incorporated in the report preceding the discussion. Mr. Alexander's criticisms are based upon the first draft of this code, which was distributed among the members in pamphlet form prior to the annual meeting.

THE CHAIRMAN, R. A. BULL.—I think it might be helpful to the discussion to ask the secretary to quote the action of the Board on this matter the other evening. The matter of the workmen's safety code was discussed at some length at that time. Incidently I might say to that I have no doubt that our Committee as a whole would recognize the value of some of the suggestions offered by Mr. Alexander. There were some that have already been covered by the modifications made since the preprint was issued; there are others that are matters for debate, of course.

THE SECRETARY.—At the meeting of the Board of Directors held on Monday evening the question of co-operating in the work of safety and sanitation with the National Founders' Association was discussed at length and a resolution was adopted at that time leaving the matter of co-operation on safety and sanitation in the hands of the President and Mr. H. D. Miles, of the Buffalo Foundry Machine Co.

THE CHAIRMAN.—Now we will be glad to have some discussion, gentlemen. The idea of the Board in adopting that motion was that this report should be adopted as one of progress and that the two organizations might promptly get together in the adoption of a code which would be satisfactory to all. I think the preliminary study which has been given this matter by the Committee of the two organizations will greatly assist the preparation of a code which will meet all objections.

Mr. H. J. Boggis.—I am vice president of the National Founders' Association, and, speaking for that organization, I will say that we want to co-operate with you, but we are unable to get together for some reason, I don't know what, and it is entirely satisfactory to us to have that committee composed of Mr. Bull and Mr. Miles, because we are going before the country on one of the most important questions there is, that of sanitation and safety in the foundry. The National Founders' Association has spent four years of work on safety and sanitation, and I think the very best thing you can do is to co-operate with them and get the benefit of their experience, and let us have the benefit of yours, and then we will go before the public at large with one code instead of two codes that differ materially from each other.

Dr. Richard Moldenke.—I do not know that I quite agree with that. The National Founders' Association represents manufacturers entirely; the American Foundrymen's Association represents both employers and employes; the molder can belong to this association as well as the foundryman.

Mr. H. J. Boggis.—We represent the foundrymen only and we will co-operate with you from that standpoint.

Dr. Richard Moldenke.—I do not believe we ought to get together and get one code.

The Chairman.—The sense of the motion was not that the joint committee should decide upon a code for adoption by the association, but should simply report to the associations.

Dr. Moldenke.—I have no objection to that at all, but I do not want this association to be put into the position of adopting a code jointly with the National Founders' Association because the National Founders' Association represents one side of the problem only. I think that a code adopted by this Association which is known to represent both the manufacturer and the workmen would be acceptable where the other would not be at all.

Mr. V. T. Noonan.—I do not agree with Mr. Alexander in his opening statement that the proposed American Foundrymen's Association code has borrowed some of its sections from the proposed safety code of the National Founders' Associa-

tion. We borrowed nothing from that code, we borrowed from the Ohio code, and the State of Massachusetts is also working on the Ohio code. I anticipated that we would have such a criticism from Mr. Alexander. It is too bad that after a number of men representing your association have given their time and services to real constructive work, for someone else to step in and try to undo all that they have done. There are a great many things in regard to this code of yours that do require changing and I do believe in co-operation and that we ought to co-operate with the other committee, but if we co-operate with the other committee, then we must co-operate with all the members of that committee and have the ideas of all the members of the National Founders' Association committee, and not the particular ideas or work of one individual only. That is what I fear when these two committees get together. I am very much surprised that Mr. Alexander should make a public, written statement that it is all right for a workman to put his finger into the eyes of another workman to remove a particle, when all authorities are agreed that it is positively dangerous to do so. Accidents reported to the Ohio Commission show that it is dangerous for any workman to put his fingers into the eyes of another workman. Mr. Boggis is one man that I personally should be very most glad to co-operate with in every possible way; I know him well, I knew him on the Ohio Committee and I am glad that he has come here.

Mr. H. J. Boggis.—I simply agreed to the suggestion because I happened to know Mr. Miles. If you want to go to the Ohio Commission and take one man, that will be satisfactory to us, and we stand ready to co-operate at any time.

The Chairman.—Mr. Miles was selected as representing the A. F. A.

Mr. H. J. Boggis.—As far as the N. F. A. is concerned, they will be glad to co-operate with the entire committee.

The Chairman.—My successor in office and Mr. Miles are appointed a committee to co-operate with the N. F. A., and I am sure that Mr. Boggis, as vice president of the N. F. A., can

assure you that our committee will get their hearty co-operation and not simply the assistance of one or two individuals on the committee.

Mr. H. J. Boggis.—Yes, we feel that way and I think Mr. Barr wrote you a letter asking for your co-operation.

The Chairman.—I thought Mr. Barr would be here today.

Mr. H. J. Boggis.—He expects to get here by six o'clock tomorrow evening. He had some very important matters to attend to which delayed him.

The Chairman.—Resolutions have been submitted by the committee with regard to neglect on the part of the employes with regard to obeying safety regulations. I am sure there will be no objections to that resolution, and the action of the Board in regard to arranging for co-operation with the National Founders' Association, it seems to me needs no action. I think it would be proper, however, to take action on the part of the A. F. A. committee and we are also indebted, particularly to Mr. Noonan. He said that he did not know how he had been appointed; it was suggested that this year the work of the Committee on Safety and Sanitation might be properly expended on a suitable safety code. Mr. Noonan was selected because of his familiarity with the subject and because Ohio was in a measure our host, and we thought that that courtesy was appropriate. Mr. Noonan has enlightened you as to whether he dominated the situation. The names of the committee members indicate that it is a committee composed of real foundrymen. Whether he would have made any attempt to dominate the situation or not, I am thoroughly familiar with the gentlemen on that committee and I know they would not have stood for it if it was not right. A motion would be in order on the adoption of this resolution; also one expressing the appreciation of the association to Mr. Noonan and to those who helped him.

The motion was seconded and adopted. The resolution is published in the summary of the proceedings of the meeting, page 11.

The Ideal Electric Furnace for the Steel Foundry

By F. J. RYAN, E. E. MCKEE and W. D. WALKER, Chicago

As the session at which this paper is to be presented will be composed primarily of men interested in the steel foundry, we will speak of the ideal electric furnace for the steel foundry only. The ideal electric steel furnace is the one that will best meet the needs to which it is to be applied in the foundry.

It should be readily adaptable to the experience and capacity of the average foundryman because the very nature of foundry practice eliminates expert labor in most cases. A short study of all electric steel furnaces now admitted to be practical will show that the single phase, or single electrode furnace is in all respects one of the most simple. Its great simplicity in operation and construction eliminates confusing details and makes it possible for the foundry to change from converter or crucible steel practice to that of electric steel with least loss of time and with least change in the existing organization.

The question of the lining to use depends upon operating and local conditions and is a prime consideration. For foundry work, the electric steel furnace converts a charge that consists almost entirely of scrap steel, which may be turnings, punchings, heavy melting steel, forgings, returns or whatever other material is available, and it is the grade of scrap available which largely determines the lining to be used. Where the scrap has the same phosphorus and sulphur content as is desired in the finished product, the acid lining is the most satisfactory and economical in practice; first, because of the ease and simplicity of operation; second, because of the difference in cost between acid and basic lining material, and third, because of the greater heat loss when refining on a

basic lining. On an acid lining the carbon, manganese and silicon can be readily controlled and any limits demanded in ordinary steel castings can be reached. An acid lining usually consists of ganister mixed with some binder and rammed very hard. It may also consist of silica brick or a combination of silica brick and ganister.

The Field for the Basic Lining

Where the phosphorus and sulphur must be lower in the finished product than in the charge or where it is not possible to secure selected scrap, the analysis of which is known, the basic lining must be used because only on a basic lining can the phosphorus and sulphur be reduced. In the production of many special steels where no reduction of phosphorus or sulphur or both is necessary, the basic lining is also used because the alloy content can be more readily controlled to the definite points that are desired, and the loss in alloy addition is less. The great increase in the use of steel castings during the past few years has carried with it a rapidly growing demand for such special steels, all of which are the result of extensive research work on the part of users. The automobile industry may be cited particularly because in that field the increase has been one of great interest to the entire steel casting trade.

On the other hand, this reducing of the phosphorus and sulphur on a basic bottom or holding the heat while making alloy additions and awaiting determinations adds considerably to the cost of production. Also the practice in the foundry becomes more technical and the field becomes restricted. In many cases this is resulting in the installation of private steel plants to meet private demands.

It may be pointed out here that many statements have been made that this or that electric steel furnace can or cannot operate on an acid or basic lining. This is a question of metallurgical skill in the operaton of the electric furnace, and not of furnace construction. The fundamental principle in electric steel furnace construction is the proper application of heat and the reduction of heat losses. Heat may be conserved as well in a basic as in an acid lined furnace, except

for the additional loss due to radiation resulting from the increased time necessary to refine the metal. It is an advantage to have a way to reduce the voltage and the power input while holding the metal for refining so as to minimize this loss and to save the linings and the steel from overheating. As regards the application of the heat, single-electrode practice differs radically from three-electrode furnace practice, in the speed of melting down, but in any event both single and three-electrode furnaces are now operating on both basic and acid linings with commercial results.

A basic lining usually is built up of magnesite, dolomite, magnesite brick or some combination of these materials. The roof of the furnace is ordinarily of silica brick as in acid practice. We might say here, that it should be possible with any electric steel furnace to change from acid to basic or vice versa whenever desired. In such a furnace the foundryman can use the lining best suited to conditions in the scrap market.

Cost of Production

Let us now consider production or conversion cost.

First and of most interest, because it constitutes the chief conversion element, we have electric power. Each power unit lost means a loss of profit on the ultimate product. As power is converted into heat in an electric steel furnace, time becomes a vital element of cost because efficiency in the use of heat consists in applying a certain quantity to secure a given result in the shortest possible time. The largest loss of heat in any heating equipment is that of radiation, and as radiation is time multiplied by surface, time again becomes an important cost element.

Realizing that time determines the measure of heat losses, we should admit that the electric steel furnace which produces the finished product in the shortest possible time is the most economical as regards power consumption for the reason that the actual power needed for the conversion of the charge is the same in all cases. We will later show by actual records the exceptionally low power consumptions

that accompany the operation of single electrode furnaces of even the smallest sizes.

The reason why a single-electrode or single-phase furnace can produce the finished product in a short space of time is because in the single-phase furnace it is possible, with a high

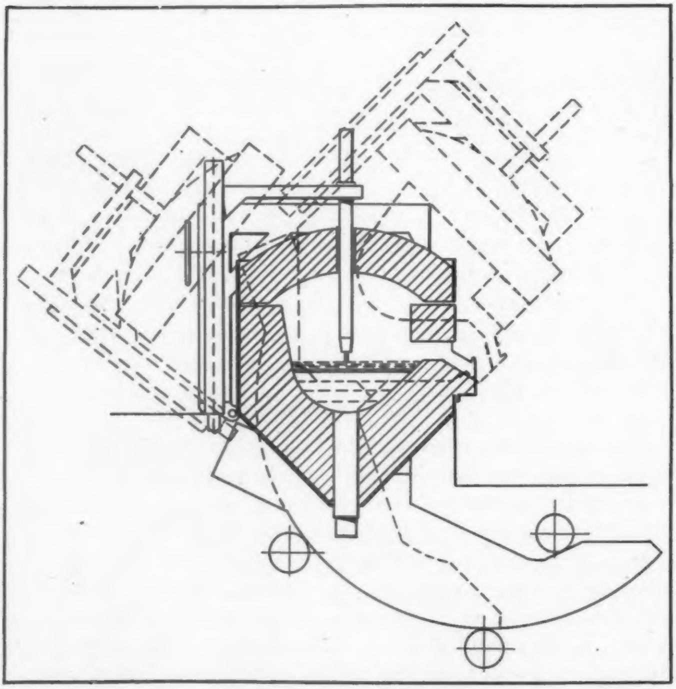

FIG. 1—CROSS SECTION OF OPEN-ROOF TYPE ELECTRIC FURNACE

voltage and a long arc, to put into the furnace more power within a given period of time.

The question of charging should next be considered because of its important bearing on the length of the heats and the extent of the heat losses. The simplicity of the electrode control apparatus in the single-electrode furnace has made it possible to develop the open roof type electric steel fur-

nace, a cross section of which is shown in Fig. 1. A general view of this type of furnace in shown in Fig. 2. This type allows quick charging, preferably by mechanical means, thereby increasing the number of heats and cutting down heat losses during charging. By plastering up the juncture of the roof and the body and closing up the spout with a sliding door, the furnace can be almost completely sealed up while melting down. There is, of course, no weakness in lining structure with such a furnace. This open-roof type of electric steel furnace has been thoroughly tested and is presented not as an idea, but as a working and practical design. A number of these furnaces are now in commercial operation.

The question naturally arises whether quick, small heats are an advantage over larger heats at longer periods—in other words, whether the steel foundry can take care of 10 to 12 small heats in 24 hours better than it can take care of six to eight larger ones. This comes down to the practice in the individual foundry, but without a doubt the majority of foundries would find it more convenient to take off five heats per 12 hours or 10 heats per 24 hours rather than three and six heats over the same periods.

The number of heats that can be secured from an electric steel furnace also has an important bearing upon the consideration of the initial price of the equipment. The logical method of measuring the capacity of electric steel furnace equipment is by output over a given period of time and not by holding capacity. We must therefore admit that the furnace which can produce the greatest amount of material over a given period of time is the most economical unit when figured holding capacity for holding capacity. The single-electrode furnace delivers the quick heats and allows great production.

Specific Figures

It is now in line to consider some specific figures of operation and cost demonstrating the correctness of the statements made in this paper.

In Table I we submit a summary of the results obtained in a ¾-ton single-electrode furnace in the plant of the Gerlinger Steel Casting Co., Milwaukee. This furnace was lined

basic. It was guaranteed to produce three tons of steel per 12 hours with power consumption at the furnace not in excess of 880 kilowatt-hours per ton of steel. In actual practice this furnace has often produced four heats of 2,000-pounds for a total of four tons in slightly more than 11 hours. The power consumption on the primary side of the trans-

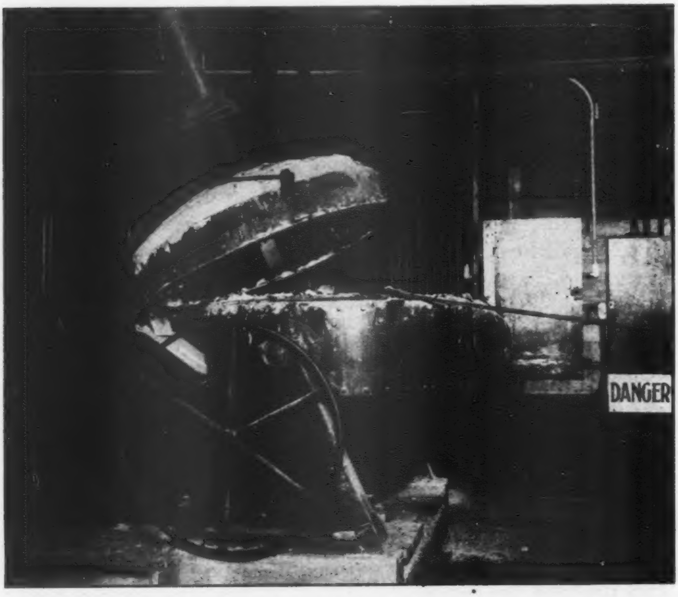

FIG. 2—OPEN-ROOF SINGLE-ELECTRODE ELECTRIC FURNACE—IN LARGER FURNACES THE ROOF TILTS BACK FARTHER TO PERMIT OF CHARGING BY MECHANICAL MEANS

former averaged only 533 kilowatt-hours per ton over the period of three months. A larger single electrode furnace has since been installed by this company and is now operating with satisfactory results.

In Table II we present a statement of physical tests of material produced in the plant of the Thomas Davidson Mfg. Co., Montreal, Canada. These results were obtained during the production of blanks for high-explosive shells in a 1½-

ton single-electrode furnace lined acid. The chemical and physical tests prove the control possible on this type of lining for foundry work.

A Single Day's Record

In Table III we give a record of a complete day's run in the plant of the Dayton Steel Foundry Co., Dayton, O. This

FIG. 3—POURING INTO HAND LADLES FROM A SINGLE ELECTRODE STEEL FURNACE

performance, the production of 14 heats of a ton apiece, melting cold steel scrap, over a period of 24 hours and 40 minutes is hard to believe. The furnace which made this run is a 1½-ton single-electrode furnace lined acid. The question naturally arises why this furnace was charged with only 2,000 pounds if it is a 3,000-pound furnace. This depends upon the practice in the individual foundry. Some overload and some underload their furnaces. In a similar furnace to that at

Dayton, the Crucible Steel Casting Co., Milwaukee, Wis., has charged as high as 3,800 pounds and averages above 3,000 pounds. In a furnace rated at 1,500 pounds the Gerlinger Steel Casting Co., Milwaukee, Wis., has charged as high as 2,200 pounds and averaged over 1,800 pounds.

We have now covered the chief points affecting the efficiency of the electric steel furnace, the points which will receive the closest attention of the foundryman who is considering the installation of electric furnace equipment. These points are the simplicity, the power consumption, the output and the initial cost. We would like to give right here some definite figures covering the various items that enter into the conversion cost. This is not possible because the conditions surrounding each individual case will call for special consideration. We can, however, take up these items one by one in a manner sufficiently explicit to give the foundryman an idea of what he will have to meet. These items include labor, refractories, electrodes, repairs, accessories, electricity and overhead. They will be taken up in the order named.

Labor.—This item will include the furnace operatives and common laborers. On a furnace up to ¾-ton size only one operator, a melter, should be necessary. On larger furnaces this melter should have an assistant or helper. The common labor will not involve a given number of men as the work around the furnace is not sufficient to require all the time of the laborers. They will be needed a part of the time for wheeling the scrap, for taking care of the ladles and for charging the furnace. The size of the furnace, the layout of the foundry, the method of charging and the method of pouring will all affect this cost.

Refractories.—The item of refractories is necessarily a difficult one to consider because the life of the roof and linings depends so largely upon the care of the furnaceman and the practice in the individual foundry. It is easy to point out isolated cases such as that of the Crucible Steel Casting Co., Milwaukee, where one roof on an acid lined single electrode furnace lasted more than 650 heats. Generally speaking the roof and side walls of an acid lined furnace

should last from 200 to 250 heats. The bottom of both basic and acid lined furnaces should last for a year or more. The length of life of roof and walls on a basic lined furnace cannot be readily approximated as it is entirely dependent upon the points of phosphorus and sulphur to be eliminated and upon the length of time that heats will be held awaiting laboratory determinations.

Electrodes.—The electrode consumption will also vary according to the care taken by the furnace operator. It is easy to point out other isolated cases such as the Crucible Steel Casting Co., Milwaukee, again where the electrode consumption over several months averaged between 2½ and 3 pounds to the ton of steel. In practice, the consumption will range from 3½ to 5 pounds per ton of metal in the ladle. The electrodes used in the single-electrode furnaces in this country are usually of graphitic carbon manufactured by the International Acheson Graphite Co., Niagara Falls, N. Y., costing about 12c per pound. The electrodes are machined and furnished with nipple joints so that they can be fed down into the furnace continuously.

Repairs and Accessories.—Repairs and accessories are a very small item of the conversion cost. They will add about 30c per ton on a ¾-ton furnace and will gradually decrease as the sizes of furnaces grow larger.

Electricity.—The cost of the power per kilowatt-hour and the number of hours the furnace operates will chiefly determine this item. It will also be affected by whether the furnace is operating on straight melting down or on melting down and refining. The method of charging is important, and the time required dependent upon whether hand or mechanical means are used. The amount of care taken in killing the metal will be another important item. These must all be considered in advising with regard to any specific case. One record of power consumption is given on Table II. Another record has to do with the single-electrode furnace in the plant of the Dayton Steel Foundry, Dayton, Ohio. The Dayton Power & Light Co. advise as follows: "From all the records we have on the Snyder Electric Furnace installed at the Dayton

Steel Foundry Co., the current consumption has not exceeded 480, in fact the average is between 470 and 480 kilowatt-hours per ton of steel." The record at Dayton is on straight melting, on an acid lined furnace, using good scrap.

Overhead.—The foregoing leaves only the items of burden or overhead, and the furnace charge and addition to be taken into account. Our practice is to charge burden in at 20 per cent to cover interest, depreciation and taxes. The charge and additions will vary in relation to the market.

We make no contention that the product produced in one type of electric furnace offers any advantage over that produced in any other type of electric furnace. All the ideas and statements here presented refer to steel foundry practice alone, the intention being to present, as far as possible, what we consider to be the ideal electric furnace for the steel foundry.

It might be well to mention in closing that the electric furnace, no matter of what type, has now passed beyond the experimental stage and has entered into actual commercial operation, entirely separated from chance or unknown results. The steel foundryman can feel that in interesting himself in the electric steel furnace he is making a step forward in his field and business. The past year has indicated clearly the position that the electric steel furnace is to take in connection with the steel founding industry. Recent statistics covering the growth of electric steel for castings show that while in 1914 there was a production of 8,551 tons of electric steel, the output for 1915 had jumped to 23,064 tons, an increase of nearly 200 per cent.

Observations of foundrymen and investigations made by men prominent in the steel industry show clearly that steel produced in the electric furnace has a greater strength and a more uniform structure than steel from converter, open hearth or crucible. This being so, the foundryman can only ask himself whether or not his business demands a change and whether or not competition from outside sources, where electric furnaces are being used, is not liable to endanger an established business that he has built up. Manufacturers in

this country are basing their purchasing requirements more and more upon figures of specific performance and actual tests. This is tending to eliminate the personal nature that business has had for many years. Therefore, it will be a question of quality and price that hereafter will largely determine the volume of business that any steel foundry is liable to obtain. If quality and price are to be the standards upon which the volume of business is to be based, necessarily the foundryman, when he begins the investigation of electric steel furnaces, should convince himself thoroughly that the unit he buys will be the most practical for his requirements and will produce his steel for the lowest unit cost.

Table I

OPERATION OF ¾-TON SINGLE-ELECTRODE BASIC ELECTRIC STEEL FURNACE AT PLANT OF THE GERLINGER STEEL CASTING CO., MILWAUKEE, JANUARY, FEBRUARY AND MARCH, 1916.

Total output, tons	274.23
Total electricity, kilowatt-hours	146,160
Average kilowatt-hours per ton	533
Average pounds per heat	1,885
Average cost per ton metal in the ladle	$28.93

Table II

CHEMICAL AND PHYSICAL TESTS ON 4.5-INCH HIGH EXPLOSIVE SHELL STEEL MADE AT PLANT OF THOMAS DAVIDSON MFG. CO., MONTREAL, IN SINGLE-ELECTRODE ACID ELECTRIC STEEL FURNACE.

Heat No.	Carbon, per cent.	Silica, per cent.	Manganese, per cent.	Sulphur, per cent.	Phosphorus, per cent.	Yield point, gross tons.	Tensile strength, gross tons.	Elongation, per cent.
64	0.45	0.20	0.87	0.039	0.039	22.5	48.3	23.2
65	0.44	0.16	0.88	0.041	0.037	19.4	38.5	22.6
66	0.45	0.15	0.80	0.049	0.036	24.1	48.3	23.2
67	0.58	0.17	0.80	0.047	0.042	22.3	47.9	20.1
68	0.43	0.19	0.78	0.045	0.040	22.9	48.3	26.8
69	0.45	0.17	0.69	0.047	0.033	19.1	35.4	26.2
70	0.46	0.17	0.70	0.039	0.038	22.5	44.5	25.6
71	0.48	0.12	0.70	0.039	0.038	20.7	39.9	21.3
76	0.41	0.20	0.78	0.047	0.038	20.7	41.6	25.0
77	0.34	0.20	0.85	0.045	0.040	21.5	46.3	19.5
82	0.41	0.29	0.76	0.041	0.045	22.1	47.4	23.6
94	0.46	0.27	0.80	0.041	0.055	23.5	48.7	23.2
96	0.45	0.24	0.62	0.039	0.041	22.7	41.7	23.2
97	0.49	0.22	0.65	0.039	0.047	23.9	49.5	15.8

Table III

OPERATION OF A SINGLE-ELECTRODE ACID ELECTRIC STEEL FURNACE IN THE PLANT OF THE DAYTON STEEL FOUNDRY CO., DAYTON, OHIO, JUNE 9, 1916.

Heat No.	Charging Time	Power on Time	Pouring Time	Finished Time	Charge pounds
93	2:06	2:50	4:00	4:12	2000
94	4:12	4:29	5:39	5:51	2000
95	5:53	6:05	7:13	7:26	2000
96	7:27	7:47	9:03	9:14	2000
97	9:15	9:45	10:52	11:01	2000
98	11:02	11:22	12:34	12:44	1800
99	12:45	1:14	2:30	2:40	2000
100	2:42	3:01	4:11	4:20	2000
101	4:22	4:46	5:56	6:06	2000
102	6:08	6:14	7:21	7:34	2000
103	7:35	7:51	8:58	9:08	2000
104	9:09	9:30	10:35	10:45	2000
105	10:46	11:06	12:30	12:52	2000
106	12:53	1:10	2:30	2:46	2000

Total time, 24 hours, 40 minutes.
Total output, 27,800 pounds.
Average charging time, 22 minutes.
Average melting time, 72 minutes.
Average pouring time, 12 minutes.
Average time per heat, 106 minutes.

Discussion

Mr. Bever.—I would like to ask Mr. Booth what the metallurgical loss is in the combined charge in the furnace.

Mr. C. H. Booth.—You refer to basic or acid?

Mr. J. J. Bever.—Both.

Mr. C. H. Booth.—The actual loss would not exceed 1 per cent in acid; in basic we have only one furnace in operation in Syracuse at the Holcomb Steel Co., and we have not been able to get specific data on that.

The Chairman, W. A. Janssen.—Are there any others who use the Snyder electric furnace who might further augment this paper?

Mr. J. Walther.—We have installed a Snyder furnace and it is satisfactory, we are very well pleased with it.

Electric Furnace Practice in the Manufacture of Steel Castings

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By T. S. Quinn, Lebanon, Pa.

The ever increasing demand for a higher grade of small steel castings, influenced the Lebanon Steel Foundry to consider the electric furnace to supplant the crucible furnaces, which up to that time constituted the melting equipment. Having decided on a basic furnace as being the most economical from a standpoint of the local scrap market, the conclusion was reached that the Heroult furnace best answered the purpose. In March, 1915, a furnace of this type, of 1-ton capacity, was installed. It was provided with Thury regulators, steel non-water cooled holders, and Gray tilting device. The furnace is of the 3-phase type. The bottom and side walls of this furnace are magnesite up to the slag line, and the side walls above, and the roof are silica brick.

Three weeks after the first heat was poured, the stack of the crucible furnaces was thrown, and the furnaces themselves were dismantled. This provided space for another electric furnace, should the normal expansion of business warrant it. In July, 1916, a second unit was installed of the same type, but of two tons capacity, and proportionately higher powered. The 1-ton furnace has a transformer capacity of only 225 kilovolt-amperes; the 2-ton size has 600 kilovolt-amperes capacity.

The product of both furnaces is small steel castings, averaging 5 to 10 pounds in weight. The castings are made for automobile, motor truck and general machinery purposes.

Data Covers One-Ton Furnace

In submitting some data in connection with the operation of electric furnaces, I shall confine my remarks to the 1-ton furnace, previously mentioned. I do not feel warranted at this time to make any statements in reference to the 2-ton

furnace, as the length of time that it has been in operation is too short from which to draw intelligent conclusions.

Up to Aug. 1, 1916, the 1-ton furnace made more than 2,000 heats on the original basic bottom. In that time it has not been out of service except for relining, which it was customary to do on a Saturday or Sunday. The magnesite bottom, which was set in layers of 1-inch to 1½-inches, is still in the furnace. In setting a bottom in this fashion a monolithic mass is obtained that cannot be equalled by a bottom rammed in with magnesite, tar and pitch. The life of a lining varies from 100 to 125 heats, and the life of a roof from 125 to 150 heats.

Amorphous-carbon electrodes are used, the consumption averaging about 25 pounds per net ton of steel in the ladle. This low electrode consumption for a small furnace of the 3-phase type probably is due to the fact that shortly after the furnace went into operation, the solid copper type electrode holders were abandoned, and low carbon steel holders substituted. Each holder has two hinges, and the bus-bars are continued on out past each hinge, to prevent any heating at this point. The advantages of this holder include the absence of any water cooling and freedom from breakage, due to torsional stresses. The ease with which an electrode can be slipped also is a decided advantage.

The operation of the furnace for the past year has been on a 24-hour schedule, and while lack of transformer capacity was a serious handicap to maximum production, the furnace made an average of six to seven heats in 24 hours. A 1-ton furnace built today would have more transformer capacity, and with say 450 kilovolt-amperes as many heats could undoubtedly be made in 12 hours, at the same time effecting economy in power consumption.

Power Consumption Moderate

Actually, the power consumption has averaged 950 kilowatt-hours per net ton of steel in the ladle, which is about what might be expected of a 1-ton furnace with insufficient power back of it. Even in the short length of time in which the 2-ton furnace has been in operation, it has been demonstrated

satisfactorily that steel can be put into the ladle at the same temperature for the same purpose, with a kilowatt-hour consumption not exceeding 750 per net ton, and undoubtedly the power consumption on 3-ton and 6-ton furnaces is considerably less than this. Every effort is made to minimize the length of time between heats, and it not infrequently happens that bottom is made, and the charge is in the furnace, and the current on by the time the previous heat is poured, a matter of some eight or 10 minutes.

The practice on this furnace has been to patch the banks with dolomite as soon as the heat is out of the furnace, and the charge is then introduced, consisting generally of what is known as heavy melting steel scrap. This scrap may have practically any analysis, as long as it is of chargeable size, and the carbon not too high. Coke is next placed under the electrodes on top of the scrap. Then the electrodes are lowered and the current turned on to the full capacity of the transformers in summer time, although in winter the furnace is often operated with a constant overload on the transformers of 25 per cent.

In about 20 minutes a puddle of molten metal is formed under each electrode, and the surges of current become violent as the electrodes arc on the metal. Lime is now added with spar and sand, and the furnace again settles down and works steadily, and in about 1¾ hours the charge is completely melted, at which stage of the operation the phosphorus has gone into the slag, where it is retained as phosphate of lime. Generally this reaction is sufficiently complete without the aid of any oxidizing agent other than the rust that is on most scrap. At this juncture the melter pours a test bar, breaks it, and by examination ascertains whether his carbon is high or low, and either ores down or pigs up, until this element is in order. If much ore is required of course more lime must be added to maintain sufficient basicity in the slag to take care of the phosphorus.

The furnace is tilted slightly and the slag is pulled off by means of a rake, an operation that takes, in skilled hands, about three minutes. The furnace is put back into place, and

the second slag is made with lime, spar and sand, and at this stage of the heat the deoxidizing and desulphurizing period begins. As soon as the slag is melted, and is of the proper consistency, powdered coke is added, and in about 20 minutes under the intense heat of the arcs, the slag becomes reduced, calcium carbide forms, and the sulphur goes into the slag, where it is retained as calcium sulphide. This reaction is very complete. However, the mere fact that a calcium carbide slag has been formed, is no indication that the steel under it is thoroughly deoxidized, and it is necessary to hold the metal under this slag at least 20 to 30 minutes to completely kill it. Manganese and silicon are next added, and the atmosphere of the furnace, and the condition of the slag at this stage of the heat is such that if for any reason it should be desirable to do so, the heat could be held in the furnace for an indefinite length of time, without any appreciable loss in the manganese or silicon content in the steel, providing the slag is carefully watched and protected from any possible oxidation from the doors, etc.

Deoxidizing Possibilities

To be able to introduce into a furnace a given amount of manganese, silicon, chrome, vanadium, etc., and hold it in the metal for an indefinite period, theoretically getting in the steel just what was introduced, is proof of the almost perfect deoxidizing possibilities of the electric furnace and of the condition of the steel as it comes from the furnace, the advantages of which must be apparent to operators of converter and open hearth, who are obliged to finish their metal in the ladle, resulting in an inferior product.

Were the whole heat to be put into a big ladle, and bottom-poured direct into the molds, there would be no necessity for the use of any aluminum, but as the practice necessitates the pouring of the metal from the furnace into a big ladle, and again pouring it into shanks, and from the shanks into the molds, it must be plain that this practice is very severe on the metal. No matter how thoroughly the steel might be deoxidized in the furnace, the tendency of the metal when it is handled so many times, and at a temperature sufficiently high to

pour very light work, is to absorb some oxygen, and a small addition of aluminum is made in each shank as a preventative rather than a cure. There have been periods, however, when no aluminum was added even in the shanks, for weeks at a time, but this practice taxes the skill of the melters to the utmost, and is not to be recommended, when shanking steel in small quantities at high temperatures.

The finishing of a heat in the electric furnace requires very nice judgment on the part of the operator, and as the process is comparatively a new one, a scarcity of experienced melters is probably often the cause of much steel being put out in the market as "Electric Steel" which is not worthy of the name.

Too much cannot be said of the physical properties of electric steel, when properly made. With a view of ascertaining what electric steel would pull in comparison with steel from the converter, and open hearth, some 20 test bars were taken from as many consecutive heats. Their average analysis was as follows:

	Per Cent
Carbon	0.23
Silicon	0.29
Manganese	0.62
Phosphorus	0.018
Sulphur	0.028

The physical properties were as follows:

Ultimate tensile strength, lbs. per square inch	71,417
Elastic limit, lbs. per square inch	43,417
Elongation, per cent in 2 inches	31.60
Reduction of area, per cent	51.00

It will be noted that the average elastic ratio was 61 per cent of the ultimate tensile strength. The only heat treatment that the test bars received was a slow anneal at about 1,600 degrees Fahr. Of the same analysis and with the same simple heat treatment, no tests from the converter, or open hearth have come to the author's attention approaching these figures.

Information on the cost of steel in the ladle for casting purposes, governed as it is by local conditions, is of little use for purposes of comparison, unless all the variable factors entering

into it are known. Therefore, the author refrains from touching on this phase of the manufacture of steel in the electric furnace.

One Hundred Furnaces Operating

However, the fact that there are in this country about 100 electric furnaces in operation is sufficient evidence that the electric furnace is commercially able to make its way, and from observation and experience it would seem logical to draw the following conclusions:

> *First,* that there is a steadily increasing demand for better steel as evidenced by the fact that the open hearth and converter steel manufacturers have been steadily called upon to improve their methods, with the result that they have standardized their practice to a point which, owing to the inherent disadvantages of the very nature of the processes themselves, can hardly be materially improved upon.
>
> *Second,* that the electric furnace is the only known available medium which promises through its almost unlimited refining possibilities and its further development to satisfy this demand.
>
> *Third,* that the eagerness with which manufacturers of steel products have embraced the electric furnace, as a means to an end, would indicate that this process will not only make its way in a new field, but will displace to some extent for some purposes the open hearth, converter and crucible. Especially is this apt to be the case in the steel foundry, where a high grade, hot metal is wanted at regular intervals, in comparatively small quantities.

Today the development of the electric furnace is hampered, if not threatened, by instances of dissatisfaction with the product, probably because it is the trend of the times to commercialize any important discovery on a large scale, and it is possible that the exploitation and installation of electric furnaces has been so rapid that the development of metallurgical and operative skill has not been in proportion. Certainly the electric furnace does not call for any better operative talent than the open hearth, and it is only reasonable to assume that when electric furnace practice is established and standardized as has been the case with the open hearth, it will come into its own.

Discussion—Electric Furnace Practice in the Manufacture of Steel Castings

The Chairman, W. A. Janssen.—I think after that paper most of you can go home and make electric steel. Is there any discussion?

Mr. M. G. Tielke.—Mr. Quinn, I notice in the paper that the consumption for the 1-ton furnace was 950 kilowatts and 750 for the 2-ton. We have practically the same furnace as Mr. Quinn, and we have the same transformer capacity in the 1-ton as we have in the 2-ton.

Mr. T. S. Quinn.—We feel that that was due to the abundance of power that we have in back of us which means ultimately lower cost.

The Chairman.—We foundrymen have so many problems of our own that it is hardly right to expect us to become familiar with electric current. I understand we have in our midst this morning Mr. E. L. Crosby, of the Detroit Edison Co., who could possibly tell us how to adapt electric currents to metallurgical operation better than any other man in this country. Mr. Crosby will now enlighten us further.

Mr. E. L. Crosby.—That was a very flattering introduction and I feel it is undeserved. The incentive for my interest is apparent; I am in the central station business and am interested in anything that is going to sell more electric energy, but it has seemed to me for many years that the subject of the application of electric heating to the metal industries, particularly to the manufacture of steel and steel castings, was a very logical one. As one of the gentlemen in his talk this morning has told you, we have a Gronwall of 6 tons capacity, one Heroult of 6 tons and another of 3 tons capacity, and I think the operation has been thoroughly satisfactory from the metallurgical standpoint to all the users, and it certainly has been

satisfactory to us from the standpoint of power consumption. When these furnaces first went on our system some of our operators became somewhat upset, but they soon got used to it and they do not mind the fluctuations. We feel that the sentiment among the steel foundries is, as has been said here this morning, that when things get back to normal and the people who are purchasing steel castings demand a chemical and physical analysis, the tendency will be to install the electric furnace. Of course they do not think it is necessary at the present time because of abnormal conditions, but when the better grade of castings are wanted, the electric furnaces will be installed. All that Mr. Clarke mentioned is true, but one thing you must all remember when considering an installation of this sort, that you should be connected up with a pretty fairly large system that has lots of surplus energy back of it, otherwise it is not going to be very satisfactory. Mr. Quinn has an example of that; he is not getting the operation he would if he had a larger transformer capacity and better service. It is quite essential that the central station supplying the service should be large and be prepared to deliver the service to you and not worry too much about rapid fluctuations in power which are bound to occur in the best regulated furnaces.

THE CHAIRMAN.—At the time of the compilation of this symposium, we hoped to have representation of all of the different types of electric furnaces in the country. Within the past year or two we have had introduced to us a type distinctly different, the Rennerfelt furnace. I see C. H. Vom Baur in the room and would be very glad to hear from him at this time.

C. H. VOM BAUR.—The Rennerfelt furnace is of a little different construction than most electric furnaces. It has a solid bottom and operates with polyphase current. I have talked this morning with a number of the members and they were speaking to me about the point that was brought out here, that the electric furnace is a cure-all for foundry troubles. I have never considered it as such, but it is just as Mr. Gray and others have said, if the furnace is properly taken care of you will get results; another very important thing is the electric

power, it must be ample and continuous. The next point is the question of refractories. The refractories have not been as good lately as they were a few years ago. Mr. Nordholt seems to think that most of the electric furnaces are running acid, but I think this is wrong, the greater tonnage run basic and the refractories are of so low a quality this item must be taken care of. I have seen roofs in open-hearth furnaces that were ruined inside of a week, sometimes less than a week, and when the roof commences to drip, you know you are going to have trouble and it will ruin the top. I have been associated with this problem for about six or seven years, and I would say that all roads lead to Rome, in so far as the personal element is concerned. I know of one case where they are running the foundry day and night and they started off the first week with 816 kilowatts per ton and the fifth week they ran 611 kilowatts per ton. They are making various grades of steel and their percentage crop loss was 11.48, and shrinkage loss, 3.39 per cent. Taking the net tonnage of 2,000 pounds, the average for seven weeks running continuously was 613 kilowatt-hours with a basic bottom; I want to emphasize that had the personal element not been efficient and they had used 1,000 or 1,200 kilowatt-hours per ton, they would have been doing well. The figures I have given you represent actual operation.

The Chairman.—The papers committee, anticipating a possible dearth of discussion on this all-important subject, wrote to a foundryman who operated a plant in which both the converter and the electric furnace were installed. Unfortunately it appeared as a paper on the regular program, but was ostensibly intended as a part of the discussion of this symposium. We will now hear from Peter Blackwood.

Mr. Peter Blackwood.—One of the most important questions occupying the minds of the metallurgical world today is the adaptability of the electric furnace for small steel casting work. A great deal has been said for and against this wonderful new unit, but at the present time I emphatically agree with what was said at Chicago convention two years ago, "That the virgin moment had not yet arrived whereby we could honestly place the electric

furnace on the same plane with the baby converter of today," for the simple reason it has not yet produced a tangible asset to the world's astonishing steel balance sheet of the last few years, and if we had not had the surprising boom steel market of the last two years, the installation of this unit would not have been carried out in half the steel foundries in which it is found today.

In making this comparison we will consider a 6-ton Heroult furnace in competition with a 1-ton baby converter, because up to the present time the latter can compete with the former any day from any given standpoint.

The essential part to be considered is the class of metal produced and we will now proceed to take this question up from a common sense plane.

All commercial grades of steel always contain besides carbon, varying amounts of silicon, phosphorus, sulphur, manganese and often an appreciable proportion of copper and traces at least of many other metals and metalloids which we will call metallic impurities. Over and above these metallic impurities we have the non-metallic impurities which consist chiefly, of oxides and silicates of iron and manganese. The latter are principally produced through the retention by the metal of some of the slag produced during the refining operation. Now there is a sharp distinction between the behavior of metallic and non-metallic impurities, the former forming known alloys with the contaminated metal; the latter being merely inclusions, their union with the metal is purely mechanical.

In the fluid slag and molten iron which exist together in the bath of an electric furnace, we have a complex system, the equilibrium of which changes with every alteration of temperature. The slag may be regarded as composed of three parts, first, the fluid mixed silicate fusion or mother liquor, second, the active desulphurizing agent which is usually lime, though it may be magnesia or ferrous oxide, and, third, the product of the action of the basic oxide on the sulphur, which in the case under consideration will be calcium sulphide. Now it may be noted that sulphides and oxides exist in slags side by side at high temperatures without acting chemically upon each

other. Now when the juice is turned off a little before the furnace is turned down for pouring, the bath chills a little. As the slag cools slowly in the large mass of metal, the calcium sulphide tends to separate from the rest of the slag, and to concentrate in that portion which remains longest fluid, namely, the metal. This concentration is in the form of small isolated islands.

When several substances are in solution at the same time each order of molecules is distributed throughout the solution unmolested by the presence of the others. The fact that molecules of different kinds can co-exist in any liquid, the proportion of each depending on the temperature, and other factors, but especially the temperature, has paved the way for a new view of allotropic modification, according to which both forms can be present in a state of equilibrium, which may be called dynamic allotropy. This dynamic allotropy can be traced to the two elements, sulphur and phosphorus. We can and do have those two elements present in two conditions, as a distinct entity, or in combination to form a sulphide or phosphide, and it is a well known fact that certain reagents have the effect of stimulating the rate at which the equilibrium between the two forms is attained, and this reagent in the electric furnace is heat. The temperature used is absolutely ridiculous for ideal steel refining, and acts as a stimulant to this new phenomenon. On the other hand, the temperature is so arranged in the converter that we have in this case a retardation to such a state of affairs. So that under the circumstances of electric furnace conditions, we have an intermingling of slag with the metal, and if any of my readers have any doubts as to the authenticity of my statement, just take a walk around some of the machine shops when electric steel castings are being machined. You will find a condition of things which will surprise you in this respect.

As a matter of fact it would pay some eminent metallurgist to put on the market tools which would be guaranteed to take a cut through those isolated non-metallic reefs at the same time that it is cutting the metal, but at the present time with nothing to meet this non-metallurgical state of affairs you are

usually shipwrecked. Consequently you have got to get a new bark in commission before attempting a further voyage through the coral reefs of electric steel. We have the same condition of affairs prevalent that used to be encountered in the old puddling process.

Now as we examine the metal in the bath before pouring we must admit we are all of the universal opinion the result is a compact mass of irregular shaped crystals or grains. The metal looks as if it had been built up in the form of a mosaic with irregular shaped stones, and usually they are so ill-defined and imperfect that it is almost impossible to decide from their external shape whether they are really crystals or simply amorphous grains.

Viewing this point microscopically, we find that the metal in the act of crystallizing rejects the impurities which collect at the crystal boundries and the particles of pure metal slowly migrate and coalesce together so that we have a heterogeneous conglomerate of adhesion and cohesion between the pure metal and the impurities. This misty membrane separates the crystals of pure metal one from the other. Obviously the mechanical and physical properties of the alloy—tenacity, ductility, elasticity, etc.—will depend upon the character of this film, and this is proven out beyond a shadow of a doubt in certain classes of work, which the writer saw with his own eyes.

It was the case of a brake spider. The castings externally looked beautiful, but had got out of shape a little. When the buyer tried to straighten them they were as brittle as amorphous tin. Of course this condition is not altogether due to this intermingling mixture of metal and slag, but part can be traced to the grain size, and this has undoubtedly some influence. As the grain size is entirely governed by the temperature, it is easily understood with an abnormal grain structure we must have had an excessive temperature with the result the metal resembles burnt steel, with its poor physical properties.

For practical purposes the physical properties of steel may be taken to depend upon (1) chemical composition, (2) distribution of constituents, (3) size of grain, and (4) the influence of stress and strain.

We have already practically covered in a small way points 2 and 3. Suppose now we confine our attention for a few moments to No. 1. During the last few years a large number of empirical observations with the testing machine have been made covering the influence of elements like manganese, sulphur, silica, etc., upon the properties of the iron-carbon alloys. We find the tenacity is lowered by elements like silicon, phosphorus and sulphur, which promote the formation of graphitic carbon, or cementite, and by elements like copper which cause the formation of other separations, as well as by elements which increase the size of the grains, and by non-metallic elements which induce the formation of thick cell walls, or which separate the crystalline grains one from the other. For instance, large amounts of silica, iron and sulphur compounds, manganese, sulphur, slag and oxides, have a bad effect. On the other hand, the tenacity can be increased by elements like nickel and cobalt, which possess a high tenacity. It may also be increased by small amounts of elements like manganese, chromium, titanium, etc., which hinder the separation of graphitic carbon, as well as by small amounts of silicon and aluminum, which hinder the formation of blow holes, and by having certain elements present in proper proportions which are in harmony with one another, and will consequently favor the formation of firmly locked crystals.

We must admit we can have all those favorable conditions present in the converter process, hence the angelic metal produced. Of course, it is understood and verified that nothing will be gained by guaranteeing sulphur, and phosphorus 0.02 per cent instead of 0.05 per cent, for we can obtain these results in the basic open hearth. The metallurgist who can take a steel with 0.25 per cent carbon, with sulphur and phosphorus 0.05 per cent, and give the market something which the trade wants in the manner of physical properties, and can guarantee his work from all physical defects, is the scientist who will gain the market at all times. When all is said and done, mighty few engineers understand the internal changes by which these effects are produced.

The impurities or foreign substances may not only react upon the iron, but also upon the carbon, and upon each other. Among the secondary reactions we have the possible formation of all kinds of carbides, silicides, phosphides, etc. Besides the formation of compounds of this type there is also the possible existence of allotrophic forms of the foreign elements, which will undoubtedly modify the properties of the alloy in a specific manner, and this has been borne out to quite a considerable extent with electric steel. We have none of those secondary components to contend with in converter steel. The blower who knows his business will give you the same ideal metal at the end of his thirtieth heat, after 11 hours blowing, as he will at the commencement of his first blow. So that when the electric furnace can be charged on Monday morning and run until the following Saturday morning, and every heat produced is ready for the market in first class condition, like the metal produced from a baby converter, then we will have some pleasure in recognizing the ability of the electric furnace as an ideal competitor to the converter as it stands today. All the talk regarding certain elements either increasing or decreasing the tensile strength of the metal is all within certain limits, just the same as the temperature which is necessary in your bath. There is always a maximum and minimum, and the ideal steel man of today is the one who can strike the happy medium for the most advantageous results.

In considering point 4, the disease may not be due to any alteration in the crystalline form of the metal, for all steel is normally in a crystalline state. In many cases the source of weakness is the joint between the grains. The network of cementite which envelops the crystal grains usually forms the principal lines of weakness. The metal when fractured will generally break through the center of this brittle envelope. The coefficient of contraction of the cementite cell walls is greater than of the cell contents. The mass is, in consequence, very feebly held together, and a sudden blow will fracture the metal. This is easily understood after you have carefully examined some of the castings, and find slag spots embedded in the metal, which disastrously break up the continuity of the mass, conse-

quently calling for a very imperfect union of the crystal grains. As the crystal grains on cooling contract unequally, and tend either to draw the grains away from each other, or to leave the mass in a state of unnatural tension, the fracture will naturally follow the granular junctions. The writer saw castings which were produced from electric steel and scrapped owing to this cause. A condition of things such as this has never been known in converter practice, as we have in this process harmonious surroundings in every detail.

I believe that the bulk of this trouble is really occasioned by the lack of uniformity in the bath. For it stands to reason your carbon content is not uniformly disseminated throughout the entire bath of metal. That portion which is in close proximity to the electrodes will carry more carbon than the area embracing the circumference. While a great deal has been said and claimed for the ideal reducing atmospheric conditions of the electric furnace, still it is good at times to have oxidation taking place for one can do many things with substances in the gaseous condition which you cannot do with the same elements in the liquid or solid form. The blower who uses his judgment in the proper direction never fears blow holes in the casting when the other foundry conditions are right, whereas, the electric furnace melter is trying to revive something which is already dead, for the bulk of the scrap which was originally advocated for this process was in such a putrified condition that an ordinary civilized person could hardly stay in the foundry for an hour or two after the juice went on owing to the huge volumes of nitrous fumes emitted during melting.

It has been claimed that electric steel has less segregation than any other steel produced, but this is an open question. When the metal is molten the various metallic impurities are dissolved in it, and some of these, like carbon, phosphorus and sulphur, make the metal more fusible. The result is the melting point is lowered, so that with the impurities not as soluble in the solid metal, they have a tendency to separate on solidification. We can readily conceive how each layer rejects some of its impurities to be dissolved by the steel liquid mass, and this concentration goes on in a general way until complete. Of

course it has no injurious effect on the metal's most important and useful physical properties, so long as they remain uniformly distributed throughout the metallic mass or so long as the steel is chemically homogeneous, but should they show any tendency to segregate, the quality of the metal will certainly be impaired.

At the present time we have undoubtedly more segregation in electric steel than converter steel, owing to the fact of the non-metallic impurities present in the former. One large steel foundry in the middle west disposed of 100 tons of steel castings with the gates and risers on as scrap owing to this deleterious propensity. As scrap is the staple food for electric furnace operation, I would imagine that it looked pretty ugly for that foundry's future when it was producing so much scrap that they could not take care of it all in their own plant, but had to dispose of their surplus outside to junk dealers.

I don't think there is any likelihood of a melting cost of anything like $35 or even $90 per ton being attained under conditions such as that. On the other hand, converter steel can and is produced with segregation almost completely annihilated. Segregation is due to the formation of fir tree crystals which grow perpendicularly to the cooling surface when the metal solidifies. They mechanically entangle some of the impurities and so prevent them from further travel. This is greatly augmented by the violent agitation which goes on in the converter bath during oxidation, for with the rapid movement of the forcible escape of the gases the fir-tree crystals are washed off, consequently preventing further growth of this pernicious condition.

The most obvious and plausible explanation of this dissimilarity of the two processes is that the relative masses of the two conditions—metallic and non-metallic—affect the cohesive ability of the molecule. It is reasonable to infer that a heavy molecule would form a better cohesive center than a light one, and if we assume this to be the case, the apparently strange results become quite rational. The above argument may not be a complete proof of this important point, but the probability of the truth of the assumption that each center represents a

definite molecule has been strengthened by the examination of the crystals as a whole.

We will now give a few moments consideration to the Heroult furnace proper. The design of the Heroult resembles an open hearth furnace very closely, when electric heat is substituted for regenerated gas and air. There are three electrodes of carbon, which lead the current to and from the charge. As the electrodes are not in contact an arc is formed, the arc being the conducting path between the poles. The intensity of the arc depends upon the amount of current which passes. Inasmuch as most substances retain their conductivity at high temperatures the degree of intensity which is theoretically possible is unlimited. Practically, however, limitations are encountered through the physical difficulties of keeping the conducting medium and the furnace walls in place. The temperature is limited by the fusion point of the material, while the furnace itself retains its solid condition.

The luminosity produced can be divided up into three parts, viz.: 85 per cent belongs to the positive; 10 per cent to the arc, and 5 per cent to the negative pole. Now the efficiency of the furnace depends on the ratio of the heat energy of the electric current usefully applied to bring about the operation of the furnace, to the total heat energy generated. The question at once arises what is the source of this energy? According to Peltier's discovery the current gives rise to an absorption of heat in the hot chamber, which is the positive, and a liberation of heat in the cold one, which is the bath, with the newly charged scrap. During the transfer a certain amount of incandescent matter is deposited in the bath. All experiments so far made on electric currents of this caliber are all consistent with the view that the energy of these currents is entirely derived from thermal energy, the current change in the circuit causing the absorption of heat at places of high temperature, and its liberation at places of low temperature.

We have no evidence so far that any energy is derived from any change in the molecular state of the metal caused by the passing of the current, or from anything of the nature of chemical combination going on in the bath. Then when volatil-

ization begins, the gaseous materials escape from the field of action, carrying away part of the heat in the form of latent heat of volatilization or as we might term it, energy stored up as potential energy, and here we have one cause of the rapid deterioration of the roof. This can, however, be eliminated to a considerable extent by sending electrical energy to the arc more rapidly than it can be dissipated by the volatilization of carbon, or in other words superheating the carbon vapor. Of course there is no getting away from the fact, we have really present two kinds of energy, one of which is capable of residing in the body, while the other traverses space with an enormous velocity, consequently creating a peculiar phenomenon. On the one hand, we have an abnormal convection wave, commencing from the crater of the positive electrode, spreading out into space attacking the wall and roof, and on the other hand we have refracted waves playing on the surface of the bath attacking the various crystals. The latter have different conducting powers in different directions, hence we have a non-uniform heating of the bath, for if the conduction had been equal on all sides the area melted would naturally be a circle, whereas we generally find it to be an ellipse. Therefore, we can argue and maintain that crystals conduct unequally in different directions. Consequently this phase has two detriments. (1) The heat waves are not conducted uniformly through the entire interior of the furnace, and this condition will naturally call for heavy repairs. (2) The unnatural condition of the crystals breaks up the continuity of the mass, hence brittle metal.

We can now readily understand the severity of this form of energy on the walls and roof of the furnace, and here the electric furnace enthusiast has some beautiful research work ahead of him in finding a very substantial refractory material. This commodity can be obtained, in fact it is known to exist in the natural condition in this country.

In the converter we have no such conditions to contend with. A converter can be rammed up with the proper lining and have 60 heats taken out of it without being touched in any way.

While the attainment of high temperatures was the first achievement which called attention to the electric furnace, and many technical uses were found for it, the latter developments have been in the direction of using electrical heating in competition with the various metallurgical processes where the combustion of fuel is employed. We know that a cheap source of heat energy is coal. On the assumption that one ton of good coal costs $2.50, and during combustion liberates heat to the extent of 14,000 B. T. U. per pound, the quantity of heat available for one cent will then be 112,000 B. T. U. According to the data compiled by the American Technical Society, with electric energy at ¼c per kilowatt hour we can only obtain 13,600 B. T. U for one cent. So you will see it does not take us long to know where to obtain the maximum B. T. U at the minimum cost. Of course, coming down to an actual efficiency level, the difference would not be nearly as great as this.

In closing we will give a few moments thought to the electrode question. We all know the consumption of electrodes in the electric furnace is very considerable. It is so much that some of the large firms on the European continent have taken up the manufacture of electrodes for their own use entirely. The raw materials usually used are retort carbon, petroleum, coke and coal tar. Retort carbon is obtained in varying quantities which will essentially call for thorough mixing to insure homogeneity in the finished product. Petroleum coke is a porous residue, produced in the distillation of crude petroleum, and is usually very fine. The binder, coal tar, is produced from coke oven gas or blast furnace gas. The carbon or coke is crushed, and subsequently sieved into powders of varying degrees of pulverization, their classification depending upon the size of electrode to be made from them. A quantity of powder of the required grade is then selected and mixed with the requisite quantity of coal tar. After further grinding it emerges as a thin plastic cake ready for compressing and molding into shape. After being shaped by hydraulic pressure the electrodes are stored for a few days in a regenerator furnace. To insure a satisfactory product periodical tests for electrical conductivity are made. The conductivity is an

extremely variable quantity, depending upon the nature of the raw materials used and upon every stage of the manufacturing process.

Current density and temperature have a most important bearing upon the life of electrodes, and while both amorphous and graphitic electrodes have their advantages, still as far as public opinion goes, the swing of the balance lies in favor of the graphite electrode, because it is less susceptible to disintegration, has a higher electric conductivity, a greater uniformity of composition and has slower oxidation under oxidizing conditions.

Most investigations of recent years have proved that the determination of certain physical properties is capable of throwing light, not only on heterogeneous but also on homogeneous equilibria. Such properties as electrical conductivity and thermo-electric power are not only dependent on the number and relative proportion of the constituent phases, but also on the concentration of some one kind of molecule within a homogeneous phase. In such a case, the property reaches a maximum or minimum for that composition of the phase at which the concentration of the molecules in question is a maximum. Therefore, the density and some other properties vary continuously within the limits of miscibility in the solid state, but the electrical conductivity only does so if the molecules composing the compound increase or decrease continuously in number from the one limit to the other.

The question now arises, have the various phases which our compound has passed through in the manufacturing process heightened or retarded the electrical conductivity to any great extent? Personally I think it decreases its electrical conductivity and weakens the electrode as a whole, because you have the definite compound in the binder which on entering into the solid condition with the component carbon strikes up a given phase. After being hydraulically pressed to a pressure probably of 2,000 tons, the original phase loses its originality with the result a certain amount of porosity has developed in the electrode making it rather brittle and more easily broken, and thus reducing its electrical conductivity.

This is one source of trouble to the electric melter and his bath. This is one of the large items in electric furnace smelting, and one which requires a great deal of looking into, for I don't see why a guarantee can't be given by electrode makers as to the freedom of their commodities from all defects.

So we find there are quite a few essential nooks and corners in the electric process still unexplored, which should be examined before this method of melting can occupy the same sphere with the perfected baby converter of today, which neglects all the shadows, only to reveal the substances of the metallurgical world as they ought to be, and this the trade obtains when buying converter steel castings.

THE CHAIRMAN.—I don't think Mr. Blackwood likes the electric furnace. I am sure we will have some discussion on this paper, both from the electric furnace people and the converter steel casting producers.

MR. G. MUNTZ.—Mr. Chairman, I am afraid to voice an opinion on this matter.

MR. E. F. CONE.—I would like to say a few words with regard to experience I have had in the testing of various kinds of steel and with reference to the consumption of ferro-manganese in various steel-making processes. I have found that in the electric process there is less ferro-manganese per ton of steel consumed and in the converter there is the largest amount. The reason for this probably is that the oxidizing conditions are greater in the converter and require more ferro-manganese to obtain the desired amount in the steel; the open-hearth is next, the basic, the acid and finally the electric. If the various producers here would testify to the amount of ferro-manganese used per ton of steel, it would be found that the electric furnace requires only 7 to 8 pounds of ferro-manganese per ton to obtain a manganese content of 0.60 to 0.70 per cent which is better than any other process. The open-hearth requires about 17 pounds per ton. I do not know about the converter, but I understand it is much more.

In regard to the quality of the steel castings made in the various types of furnaces, Mr. Quinn in his paper has called attention to the elastic ratio of the steel as made at his foundry

and it seems to me that the elastic ratio is the important factor in deciding the physical or static quality of steel or steel castings, but the methods by which it is obtained influence the result. Of course it is possible to obtain almost any elastic ratio, depending upon how you take it or run the testing machine, but I understand that the method used in obtaining these tests of Mr. Quinn was by the drop of the beam and checking this with the dividers, which is probably the best method to obtain accuracy, outside of the extensometer. It is the method most commonly used although not always checked by the dividers.

The physical properties of steel castings depend upon the heat treatment. Another factor entering into this is the conditions under which the steel is poured and whether it is cooled slowly or quickly. All these things affect the physical properties and also the method of cooling the steel after it is annealed. I am told by Mr. Quinn that his tests represent steel that they heated to the proper temperature and allowed to cool slowly. I have made a great many tests of open-hearth steel castings so treated, and the highest elastic ratio, judged by the drop of the beam, checked by the dividers, was 51 or 52 per cent. With the vanadium 0.17 to 0.19 per cent in the steel castings, and with the same heat treatment, the elastic ratio, as determined by a large number of tests, was 61 per cent. In the case of electric steel, annealed by the same method as I referred to before, slow cooling from the proper temperature, the elastic ratio taken by the drop of the beam and checked by the dividers, the elastic ratio is equal to the vanadium steel—61 per cent. Similar tests of crucible steel, annealed in that way did not give any higher ratio than 52 per cent or the same as open-hearth steel. Open-hearth steel, annealed by the method of quick cooling, gave an elastic ratio of 61 to 62 per cent, making it equal to the electric steel. What electric steel would do under similar circumstances I do not know. Probably the elastic ratio would be still higher, 70 to 72 per cent. The reason for this is that the metallurgical conditions in producing steel in the electric furnace are better than with the converter and open-hearth; the steel is purer, so far as oxides and nitrides are concerned. When you come to sulphur and phosphorus,

electric steel is unquestionably better, especially the basic, by which you can produce metal that will meet any specifications.

Mr. E. B. Clark.—One point is mentioned in Mr. Blackwood's paper which I think is of interest and upon which some misunderstanding exists. This is the question of machining electric steel. I happen to be connected with a company which makes and machines a comparatively large number of electric steel castings. Our experience shows that it is true there is a difference between electric steel and other steel regarding its machining qualities. The man operating the machine tool will tell you that the electric steel does not machine as fast. It is tougher for the same carbon than the other steel. To the man who is interested in the final quality of the product, however, this is an important consideration. Electric steel may not machine as easily as other steels, but it is more uniform, and, therefore, better. Steel does not machine as easily as iron, but it is stronger. I have found that electric steel, although dense and tough, is uniform and, therefore, more easily machined to the very close dimensions which are necessary in automobile practice.

Mr. C. H. Booth.—I would like to present the following extracts from a letter, if you will permit me to do so:

> "We pour all of our steel from bottom-pour ladles. consequently, any slag which occurs in our steel castings must necessarily have been carried in suspension in the molten metal. We are glad to say that our castings are entirely free from inclusion of slag. There is sometimes an inclusion in the skin of the castings of sand gathered from the sides of the mold by running steel. This, however, cannot be properly confounded with slag even though it is sometimes partially melted.
>
> "We find no conditions of unequal distribution of alloys in our steel such as are mentioned in your letter. We at first frequently made tests after addition of alloys, to find out whether or not they were being properly mixed, taking spoons of metal from different points in the furnace for analysis. Such tests showed that after the addition of pig iron there is an even content of carbon within five minutes after it is melted. This is true also of manganese, and in the case of silicon the dissemination is very much quicker.

"There is no trouble in controlling the heat of an electric furnace, that is, allowing it to raise the heat of the steel as high as is desired. It is our opinion that the heat of the steel from the electric furnace is on the average not so great as that from a converter.

"It is the belief of the writer from what he has observed in the electric furnace, that the more heating of steel up to temperatures within the capacity of the electric furnace has no particular effect on its nature when it is cooled again, if it is properly protected from the action of the air. This protection it is, of course, the duty of the furnace man to provide."

MR. H. D. KELLY.—Mr. Blackwood's paper was very interesting in many particulars, but there were two or three statements that he made that seemed to me to be technically wrong. I may have misunderstood him when he said the carbon is at the maximum at the time of melting; that is contrary to ordinary practice. I further understood him to say that the high phosphorus tends to make high carbon; that is contrary to practice because by the addition of high phosphorus we can absolutely eliminate all carbon down to a trace of combined carbon. Another point that might be of interest to operators of electric furnaces is this suggestion, although I have never operated one myself—the saving in ferro-manganese. The point is that the furnace operator has given close study to the production of high manganese; I have gone into this and find that there is very little slag with high temperatures which can be easily attained in an electric furnace; also, that there is a greater recovery of manganese and a lesser consumption of it in electric steel furnaces.

THE CHAIRMAN.—I believe the papers committee, in a measure, has brought about the desired results in the compilation of this symposium. We brought together the opinions of the various exploiters of this all-important new unit. We have had comparative data and discussions from those who are simultaneously using several types of melting units; we have had discussions from those using electric furnaces; we have had discussions from those using the basic, the converter and the open-hearth; we have covered the entire situation. You all

know that this is more or less revolutionary, and we are only really beginning to learn the true merits and possibilities of the electric furnace. As one author stated, in a great many shops the electric furnace has only served to melt the steel and the product is made in the ladle, and the product is known as *electric steel;* but it would be just as variable as if made in some other type of furnace. We have been swayed by the enthusiasm of inventors, and many were led to believe that the installation of the electric furnace would eliminate all troubles. There are rule-of-thumb methods in the foundry because of conditions and methods that have been practiced; in a very large number of shops they are handed down from one melter to another and are accepted as the policy of the shop. The older men are rather reluctant to adapt themselves to any innovations for very distinct reasons. They are accustomed to a particular type of unit and because of their years are unable to reconstruct themselves to a new order of things. It has been my pleasure to conduct tests on the various methods of making steel, and the proposition, as I see it is comparative, entirely. We have advanced through the different stages, first the crucibles as a normal standard, next the converter, the basic open-hearth, the acid open-hearth, and the relative comparative qualities of steel are primarily a matter of the absence or the presence of oxidizing conditions. We have a right to expect better quality of steel from the old-time crucible and acid open-hearth; we are making a good quality in the converter and basic open-hearth and we have a right, before installing the electric furnace, to expect a quality of steel that will be uniform.

The Electric Furnace in the Foundry

By EUGENE B. CLARK, Buchanan, Mich.

So much has been written about the electric furnace that the subject seems to the writer to be worn threadbare. It is discouraging to attempt to present anything new with reference to this question, so what I have to say is more in the nature of general observations than of technical discussion.

There are four principal methods of providing hot steel for use in the foundry, these being the crucible furnace, the open hearth furnace, the small converter and the electric furnace. Each method of steel production has its field and its advantages, as well as its disadvantages.

The crucible furnace is cheap to install and easy to operate, but it produces steel in very small units and its operating costs are high. No refining is possible. Specially adapted scrap is required. The high price of this special scrap, together with the high and increasing costs of crucibles and fuel oil, seem to make the cost of producing steel by this method almost prohibitive.

The open hearth furnace, for medium and large steel castings, is an admirable steel making apparatus. Thoroughly refined steel can be made of easily obtainable materials. The open hearth furnace does not lend itself to a small production, however, and therefore is really only adapted to foundries having a comparatively large output, which generally means fairly large castings. The open hearth furnace will probably always hold its own in the field for which it is adapted.

The small bessemer converter, certainly until the electric furnace became easily obtainable, was probably the best steel making apparatus for most steel foundries. It is flexible as to production, inasmuch as small heats may be taken out with

comparative rapidity. It produces hot steel, which, if good materials are used, may be of good quality. Its costs of installation are low and its operating costs are satisfactory.

Advantages of the Electric Furnace

The principal advantage of the electric furnace method of steel production is the high quality of the steel which it is possible to produce. Thorough refinement is possible. The cost of installation is high per ton of daily output. The cost of operation under average conditions approximates closely to the cost of operating the open hearth or the converter. If favorable operating costs are to be obtained, the electric furnace is less flexible than the converter. It should be operated continuously in order to secure low costs, and continuous operation of the electric furnace may not fit in nicely with the requirements of the foundry.

Notwithstanding these disadvantages, the use of the electric furnace has grown rapidly in recent years. This has been due partly to the demand for a high grade of metal and partly to the desire on the part of foundries whose business is increasing to try out the electric furnace. Probably the principal reason for the rapid increase in the number of electric furnace installations, however, is the enthusiastic activity of men engaged in the development and sale of electric furnaces and the desire of the progressive foundryman to be as well equipped as his competitor. One furnace installation has led to others in many cases. This may seem like robbing the electric furnace of the credit for developing on its own merit, though it is not so intended. I wish to be clearly understood as not speaking in a manner at all derogatory to the electric furnace, and yet I feel that so much enthusiasm has been displayed in presenting its advantages that a word of conservatism and caution will not be out of place.

Electric Furnace Has Disadvantages

A belief hastily arrived at that the electric furnace is a cure for all the evils and troubles in the foundry will inevitably lead to disappointment. The electric furnace has some marked advantages, and it also has some annoying disadvantages. A

foundryman contemplating the installation of an electric furnace should clearly understand both its advantages and its disadvantages. If he wants to produce an extremely high grade of molten metal and has a market for a product which will require this highly refined steel, then he has a very strong argument for the installation of an electric furnace. Many electric furnaces have been installed, however, where such conditions have not existed. It should be understood that all the metal which goes through an electric furnace is not necessarily of a high grade. While it is possible to produce high grade metal, it is by no means true that the furnace itself will produce such metal unless it be operated properly.

The average steel foundry in the past has not been equipped and organized to produce highly satisfactory results from a metallurgical standpoint. The foundryman uses steel merely as an incident in his business. The older methods of producing steel have been to a large extent "rule of thumb". The operation of an electric furnace can be reduced to routine practice with satisfactory results, but this will not be accomplished without the serious effort of a skilled metallurgical management. It is not possible for the average foundry to buy an electric furnace, set it up and start it, like a molding machine. Steel making has its annoyances, no matter what method may be used, and it should be realized clearly that the finer the apparatus, the more skillfully must it be operated to attain to excellency of results. It is something like photography. Almost any one can obtain pretty fair results with an ordinary camera. An unusually fine camera will permit of much better results, but the camera itself is only the tool. The photographer must be highly skilled to get the best results out of the finest camera.

Should Be Supported By Evidence

The foregoing remarks are in the nature of general observations and, like all general observations, should be supported by evidence. The electric furnace has many enthusiastic and active advocates. In fact, the development of the furnaces has been largely in the hands of inventors, who are proverbially enthusiastic. The very fact that an intending user of an electric furnace will be confronted right at the start with an embarrass-

ing number of different types of furnaces which he may install, each one of which goes by the name of the man who was interested in its development, is evidence of the great variety of ideas and opinions of different men as to what style and type of electric furnace is best. The intending purchaser must decide between not only an arc or an induction furnace, and between various types of each, but, having decided on the general type, he then is confronted by the necessity of selecting a Heroult, a Stassano, a Girod, a Snyder, a Gronwall, a Rodenhauser, a Rennerfelt, or one of a number of others. Such a list certainly is confusing. They cannot all be the best, and the thinking man quickly reaches the conclusion that where there are so many differences of opinion there must be many knotty problems.

To pass from the abstract to the concrete for a moment, let us consider briefly the operation of an electric furnace.

It consists of a crucible or hearth, into which is charged either partially refined molten metal or cold scrap. If the latter, then the first operation consists in melting the charge by the application of electric heat. Up to this point there is practically no difference between the electric furnace and an ordinary crucible. This molten metal may be tapped into a ladle, into which deoxidizing agents and alloys may be added. This method practically consists of making steel in a ladle and is not to be considered as true operation of an electric furnace. Under such conditions, the steel will not have the high quality which gives the chief claim for virtue to electric steel. The furnace is merely a melting pot, and the steel produced condemns rather than supports this method of steel making. Notwithstanding this fact many electric furnaces, in fact probably most electric furnaces in foundries, are being operated in just this way.

Melting Operation is Preliminary

On the other hand, if the true advantage of the electric furnace is to be realized, the melting operation is merely the preliminary one. After that a metallurgical treatment of the molten bath is to be accomplished. This is done by the proper manipulation of slags. It is at this point that skill and metal-

lurgical knowledge is necessary. Inasmuch as high grade steels must be lower in phosphorus and sulphur than the average scrap available for charging, it is necessary, generally speaking, to build the electric furnace with a basic lining. The heat supplied electrically is in such intense and concentrated form and the restricted size of the furnace brings the walls in such close proximity to the arc that delicate regulation is necessary to introduce the heat into the metal without at the same time scorifying the roof, walls and banks of the furnace. This situation is further complicated by the fact that the highly basic slag required for proper refinement is such a poor conductor of heat. Also, when the furnace lining is attacked the composition of the slag is immediately altered and the metallurgical reactions seriously interrupted. When the proper reducing conditions are obtained during the refining period, the copious white fumes which fill the furnace make it difficult for the melter to watch the brick work and to know when a fluxing temperature has been reached.

The absence of a flame, with attendant excess of air, in the electric furnace, while making possible the attainment of conditions peculiar to electric refining, and while in many ways a highly desirable feature, will not of itself insure deoxidized metal. The bath in an electric furnace is as much oxidized as any open hearth heat—in fact, dephosphorization absolutely requires an over-oxidized bath. Successful refining, to be thoroughly done, requires the complete removal of the first slag and the making of a second slag under the action of which the metal is to be thoroughly deoxidized and desulphurized. The proper manipulation of these slags must be in the hands of a man who knows what he wants to do and how to do it. In other words, he must have metallurgical knowledge. The chemical reactions are simple and easily understood, but they are accomplished under conditions which are not easily controllable except under the guidance of skilled operators.

The Question of Cost

Finally, the question of cost must always be borne in mind. It is easy to destroy or seriously damage the lining of a furnace in the efforts to control a refractory heat and bring it out of

the furnace as high grade steel. At best, the life of roof and walls is short, compared to that of the open hearth, and the small tonnage produced necessarily means high repair cost per ton of steel. In unskilled hands, the electric furnace is likely to prove a source of disappointment in its performance, but when perfection of practice is reached the electric furnace will produce metal of the highest quality. If such a grade of steel is required, and *if it can be used profitably,* the electric furnace will amply repay its difficulties of operation. I have no hesitation in saying that if a foundryman requires a better steel than can be produced readily by other processes, and if he is willing to provide the skilled operating management necessary to produce such steel, he can install an electric furnace with the assurance that he has the best piece of metallurgical apparatus available to secure his desired results.

Discussion

THE CHAIRMAN, W. A. JANSSEN.—Mr. Clark comes from a successful foundry using the electric furnace and he has certainly given us a very able dissertation on this subject. We will be very glad to hear from others who have electric furnaces in their shops, those who are contemplating the installation of such furnaces, or still others who are merely interested. I am sure Mr. Clark would be very glad to answer your questions.

MR. R. F. FLINTERMAN.—Mr. Chairman and gentlemen: I have not very much to say on the subject. I think one point should be emphasized and that is that the electric furnace is not the means of escape from all foundry troubles; without doubt it requires a more careful handling than any other type, and this should be firmly fixed in the minds of any possible buyers. I think we will see a great many changes in the next two or three years; I don't mean changes in the furnaces themselves, but in their operation. One of the great difficulties that confronts us is the matter of high temperature.

The Chairman.—We have with us at this session many of the representatives of various builders of electric furnaces. They have appeared on our programs many times when the electric furnace was still an innovation, and we would be glad to hear from some of them; we ask them to give us the benefit of their experience. Mr. Gray, have you anything to offer.

Mr. James H. Gray.—Mr. Chairman, I think the subject has been so admirably handled as far as it has gone that I have nothing to add at this time.

Gronwall-Dixon Electric Melting and Refining Furnace

BY JOHN A. CROWLEY, Detroit

Over a year ago the first Gronwall-Dixon electric melting and refining furnace was installed at Detroit. In conjunction with the basic Gronwall patents, there were combined certain American patents secured by Joseph L. Dixon. The Gronwall-Dixon furnace operates on a 2-phase system, energy being taken from 3-phase supply through two banks of transformers connected by a modified Scott 3-phase to 2-phase connection. In units of five tons and larger capacities, four vertical electrodes are introduced through the roof. The bottom electrode is embedded under the lining of the hearth and is entirely protected from the molten charge. It therefore requires no water cooling. In capacities smaller than five tons, two electrodes are introduced through the roof.

Under the Gronwall-Dixon patents, the transformers are arranged to deliver a current at varying voltages, which are immediately available as required by the operator. Each phase of the 2-phase current, which takes a balanced load from the 3-phase supply mains, is carried to a pair of the vertical electrodes, the bottom electrode being joined to the neutral point of the transformers.

Arcs Can Be Thrown in Series

Through a special arrangement of switches the arcs can be thrown in series, or in parallel or in several intermediate positions between series and parallel. During the melting stage while the arcs are in series, the lower electrode greatly accelerates the process by carrying a considerable proportion of current, as well as all the unbalanced loads, which in commercial operation are unavoidable. Because of this feature, the power

input to the furnace may be greatly increased over and above the amount it would be possible to carry without the bottom electrode. In subsequent periods of refining, recarburizing, and introducing alloys, or for holding the bath, the voltage can be reduced, shortening the arc, thereby lessening to a marked degree the reflected heat on the walls and roof. This procedure prevents rapid destruction of the refractories. When operating with a short arc the parallel or one of the modified connections are used, passing a large proportion of current through the bath to the bottom electrode. By this method the proportion of current flowing through the lower electrode can be varied within wide limits. From the power companies' point of view this transformer and connection arrangement makes a highly desirable load. The transformer efficiency is 98 per cent or over, the power factor is 92 to 97 per cent, and the service mains and power station are not disturbed by any serious surges. Small surges that occur during the melting period are absorbed by the interlocking of the phases by the transformers.

Tilting Type Furnace

The Gronwall-Dixon furnace is cylindrical in shape and of the usual tilting type. The tilting operation is carried out through worm driven connecting rods operated by motor drive through a reversing controller. The furnace is designed with two doors front and back. The front door is a combination pouring and charging door, the spout being removable. The use of two in place of three doors, as is customary on electric furnaces, reduces the heat losses.

The roof is built up in a supporting ring from regular and special shapes of silica brick. The entire roof is removable and by providing a spare roof, very little time is lost in replacing, in case one is burned out.

The electrodes are carried by an overhead support made up of I-beams. Their weight is taken up by a counterbalance to which the mechanical gearing for the control is attached. This control is operated by an individual motor for each electrode, which is energized through a system of contactors located

on the switchboard, either automatically or by a hand operated push button station. Instruments for indicating the amount of current and voltage in each electrode are placed on a separate panel adjacent to the control and under immediate observation of the operator. The amount of current to be passed through each electrode can be set at a number of different steps by the operator. The current will be maintained at such point by the automatic control. All levers for operating the switches are brought to a panel so that the entire operation of from one to four furnaces may be carried out by one melter and his assistant.

Five-Ton Furnace

The furnace installed at Detroit for the John A. Crowley Co. is of five tons capacity. Up to Aug. 1, over 800 heats of alloy steel for automobile and aeroplane construction had been poured. The results obtained have been so encouraging from both a commercial and a metallurgical viewpoint, that an additional 10-ton unit is now being installed and arrangements for still further additions have been made.

The operation of this furnace is continuous. The cold charge, consisting of various kinds and grades of scrap together with a percentage of pig iron, is charged into the furnace and from this material heats of high-grade nickel, chrome-nickel, chrome-vanadium, high silicon and high manganese, high carbon and high speed steels may be made within a period of four to five hours, with an energy consumption of from 500 to 600 kilowatt-hours per ton. Under favorable conditions many heats of steel refined to under 0.02 per cent sulphur and phosphorus have been completed in a little over three hours with a minimum energy consumption of 460 kilowatt-hours per ton. In making the above grades of steel, practically 90 per cent are to carbon specifications, requiring generally considerable recarburizing of the bath as well as the addition of the necesary alloys. The specifications are in all cases exacting, and the charge must be held in the furnace while a sample is analyzed for carbon, by the combustion method, manganese, nickel, chromium and vanadium, according

FIG. 1—GRONWALL-DIXON ELECTRIC MELTING AND REFINING FURNACE IN OPERATION

to the grade of steel made. The above figures on power consumption include the time and energy consumed while the laboratory work is being completed.

Cost Per Ton

The cost per ton of liquid alloy steel, refined to under 0.025 per cent sulphur and phosphorus, produced in a 5-ton Gronwall-Dixon electric melting and refining furnace follows:

Electric energy 550 K.W.H. at 0.08c	$4.40
Electrodes, 20 lbs. at 5½c per lb	1.10
Refractories	.40
Alloys*	.94
Slag Mixture—60 lbs. lime per ton of steel; 6 lbs. fluorspar per ton of steel; 10 lbs. anthracite coal per ton steel	.25
Scrap and Iron	14.00
Skilled Labor	.70
Unskilled Labor	.30
Total	$22.09

*To raise the manganese content 0.30 to 0.40 per cent from 38 to 50 pounds of 80 per cent ferro-manganese are added in a 5-ton furnace, or approximately nine pounds per ton of steel. At 8½ cents per pound the alloy addition cost is 76 cents. To bring up the silicon content in the steel, to approximately 0.15 per cent it is customary to add 6 pounds of 50 per cent ferro-silicon which at 3 cents per pound makes the cost 18 cents.

Conversion costs per ton on steel castings in a 5-ton Gronwall-Dixon furnace follow:

Electric Energy, 500 K.W.H. at 0.08c	$4.00
Electrodes, 20 lbs. at 5½c lb	1.10
Refractories	.40
Alloys—See note at foot of previous table	.94
Slag Material	.25
Scrap and Iron	12.00
Skilled Labor	.60
Unskilled Labor for charging and handling scrap	.12
Total	$19.41

That the furnace operates with almost an absolute neutral atmosphere was recently shown by several very interesting demonstration heats made for a company particularly interested in reclaiming high-manganese scrap. Representative samples of the scrap charged showed a manganese content of 12 to 13 per cent and after melting in the furnace samples were taken

from the molten bath the analysis showing an average manganese loss of slightly less than 0.75 per cent, far in excess of the amount of manganese the interested company was able to retain in the metal by any other furnace or melting process.

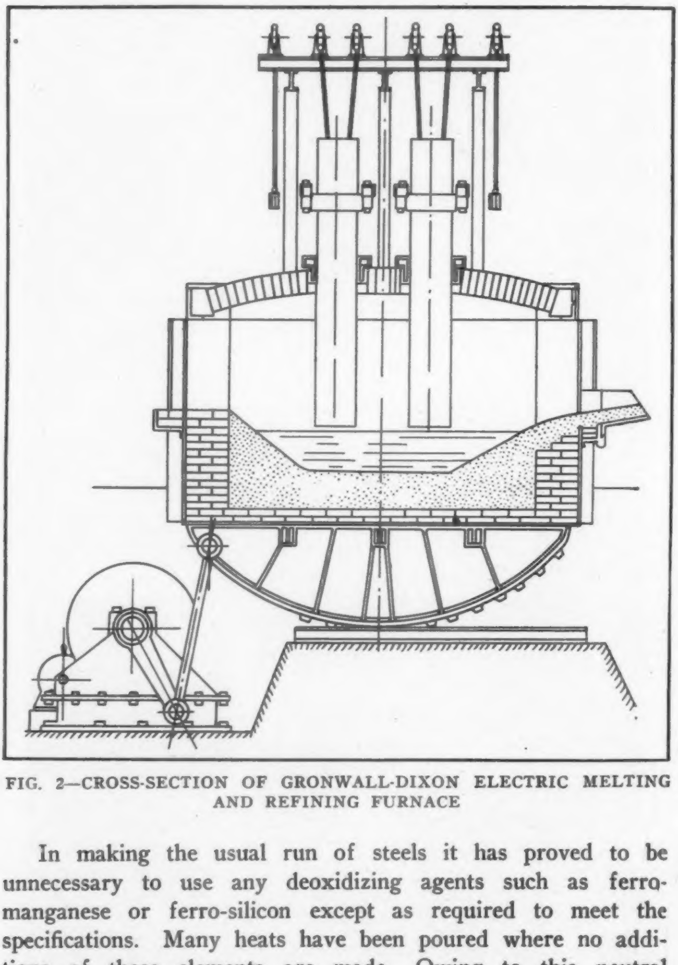

FIG. 2—CROSS-SECTION OF GRONWALL-DIXON ELECTRIC MELTING AND REFINING FURNACE

In making the usual run of steels it has proved to be unnecessary to use any deoxidizing agents such as ferro-manganese or ferro-silicon except as required to meet the specifications. Many heats have been poured where no additions of these elements are made. Owing to this neutral

atmosphere it is possible to add the greater part of the required alloys either with the scrap or immediately after the charge

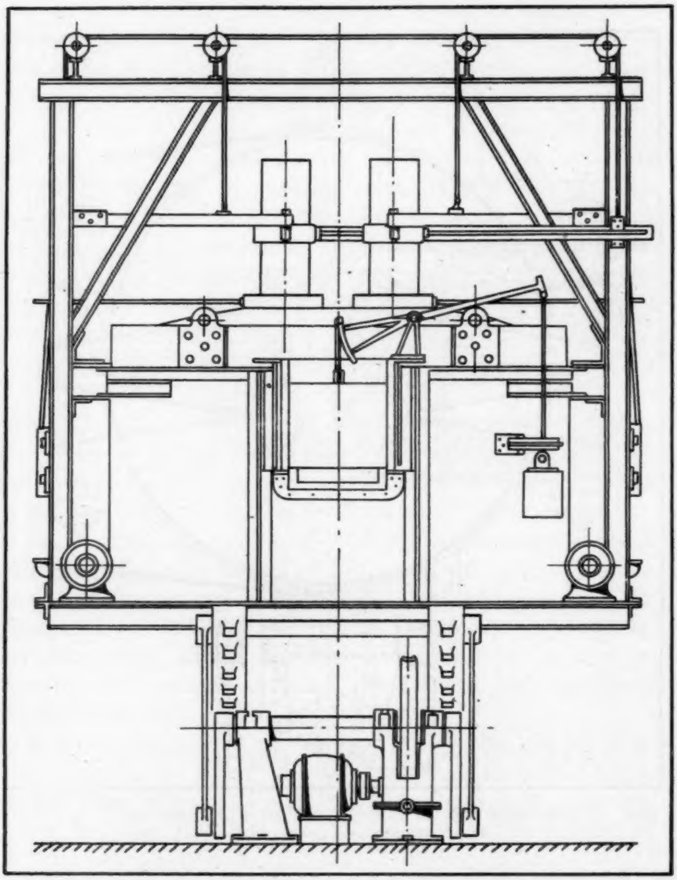

FIG. 3—ELEVATION OF CHARGING SIDE OF GRONWALL-DIXON ELECTRIC MELTING AND REFINING FURNACE

is melted, reserving only sufficient for a final adjustment of the analysis. Investigations of alloy steels made under this

practice have shown an absolute uniformity and extreme accuracy in meeting specifications.

After the melting operation, and during the refining, the

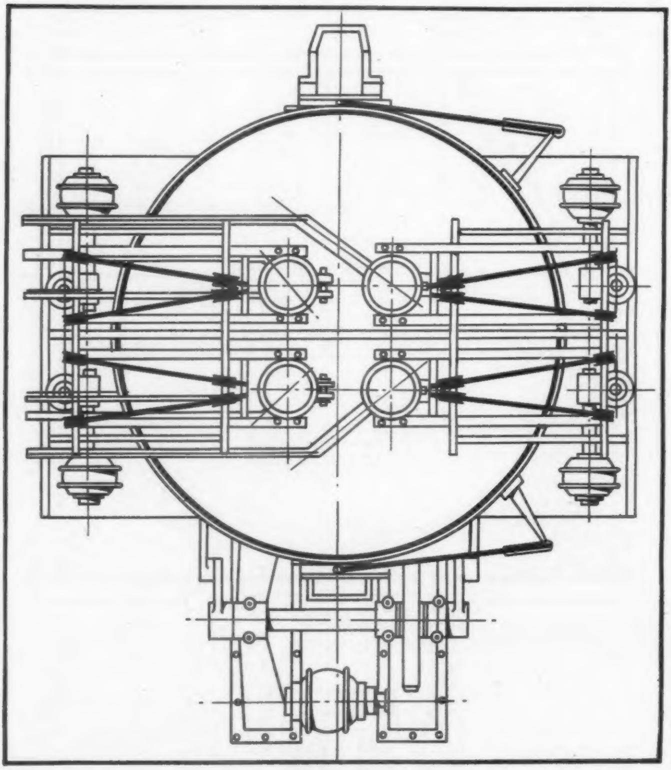

FIG. 4—TOP VIEW OF GRONWALL-DIXON ELECTRIC MELTING AND REFINING FURNACE

passage of the current through the molten metal creates a magnetic movement of the bath producing three distinct results.

First.—It brings the entire bath in direct contact with the refining slag, materially assisting in removal of the sulphur and phosphorus. It is therefore possible, starting with a charge

averaging as high as 0.10 per cent in sulphur and phosphorus, to reduce these elements with one slag to under 0.03 per cent. Frequently the phosphorus and sulphur has been reduced to 0.01 per cent with an additional slag. Extensive investigations of more than 800 heats have shown a minimum of segregation even in the piped section of bottom poured ingots.

This rapid reduction of the sulphur and phosphorus is also brought about by the passage of the current through the bath as it overcomes the tendency for the arcs to skim along the surface of the slag by drawing them directly into it. This method produces an exceptionally high temperature, particularly desirable when introducing the desulphurizing slag, which must be made highly basic and still kept sufficiently fluid to complete the removal of the sulphur. As there are no oxidizing gases present, the sulphur is held in the slag.

Second.—This motion of the bath brings all of the charge under the direct influence of the arcs, and cold rings at the edge and chilled bottoms have never been experienced during the operation of the Gronwall-Dixon furnace in nearly 800 heats. It is therefore possible to pour all of the metal, leaving the furnace entirely clean for the succeeding heats.

Third.—This magnetic action of the bath produces a distribution and amalgamation of all the added alloys. This is particularly noticeable when making final additions for the adjustment of the analysis, such as metal for recarburizing, ferro-manganese, nickel, chromium, or vanadium as may be required, after which additions the furnace can be tapped within 10 minutes.

That this passage of the current through the hearth is of decided benefit is shown by the fact that the initial lining installed when the furnace started, nearly a year and a half ago, is still in good condition, and gives promise of lasting an indefinite period.

Refining Cupola Metal

Another field for this furnace is the electric refining of cupola metal. Some of the results have been most encouraging. In one case fluid metal was taken from the cupola and refined in

the electric furnace, the final analysis of the iron being as follows:

	Per Cent
Silicon	1.980
Phosphorus	0.313
Sulphur	0.044
Manganese	0.73
Combined carbon	0.63
Total carbon	3.28

From the metal a test bar of 1 inch square section was cast, the physical test being as follows:

The bar was supported on knife edges 12 inches apart and sustained a load, applied in the middle, of 3,050 pounds before breaking, the deflection being 0.215-inch. The tensile strength was 27,570 pounds, with a Brinnel hardness of 202.

This is an instance of many excellent results, but so far the work has been carried on only in an experimental way, and in the commercial practice for producing this grade of metal these results should be improved upon.

The figures above as regards output and energy consumption are based on the making of high-grade alloy steels to meet severe specifications. In making the ordinary run of steel castings these figures can be greatly reduced, more especially as no time need be lost in sampling and analyzing the metal during the actual operation.

It is believed the capacity of the furnace and its electrical auxiliaries can be modified to meet any required conditions of output. Generally speaking, a steel foundry requires a large number of small heats in quick succession. This is obtained by reducing the capacity of the furnace hearth itself and increasing the transformer capacity so that the charges are melted quickly.

Discussion—Gronwall-Dixon Electric Melting and Refining Furnace

Mr. H. D. Kelly.—I would be glad to have the analysis of the mixture that went into the cupola when the results were obtained as shown on page 11 of the printed pamphlet containing this paper.

The Chairman, W. A. Janssen.—Will you kindly answer that? The gentleman desires to know the character of the mixture referred to.

Mr. J. L. Dixon.—I don't remember; I did see the report at one time. I believe it was put in the electric furnace in liquid state, and I think the sulphur was reduced to 0.04 per cent; of course it was higher than that when charged. The silicon and carbon were also changed in the electric furnace.

Mr. H. D. Kelly.—Another question: Was the demonstration made for the purpose of showing how much scrap was used, or for the purpose of proving that the sulphur content could be reduced?

Mr. J. L. Dixon.—It was not a demonstration carried out by our firm, but a series of experiments by a large manufacturer to ascertain whether he could get an improved quality of product. In some cases he did get an improved product, while in other cases the product was too good—and by that I mean that when the mixture was kept in the furnace too long, it became too soft.

Mr. H. D. Kelly.—What would you estimate the cost to be per ton of refining in a 10-ton electric furnace; that is, if it were high sulphur that you were working for?

Mr. J. L. Dixon.—I take it you are referring to cast iron.

Mr. H. D. Kelly.—Yes, sir.

Mr. J. L. Dixon.—I could not give you that from memory, but could work it out for you. The metal would remain in the furnace about an hour, and the energy consumption, keeping

cast iron at the refining point, would be about 50 kilowatt-hours per ton; the electrode consumption would be approximately 5 pounds per ton of metal treated. The refractory cost would be very low because there would be no necessity for high temperatures. The temperature during refining would be lower than that necessary in the production of high carbon steel castings. The labor charge would be small, the metal of course would be handled in a liquid state. Altogether, the cost per ton would be energy at about 50 cents, refractories somewhere about 10 cents, electrodes 0.28 cent, while it would be safe to assume the labor charge would be 10 cents per ton or less.

MR. M. G. TRELKE.—On page 363 you give the kilowatt-hour consumption as 500 for steel castings and 550 for ingot steel. Why should the kilowatt-hours be greater for ingots than for steel castings, which necessarily require hotter metal?

MR. J. L. DIXON.—We have assumed that in steel castings it would not be necessary to carry out the refining to the same extent as that required in alloy steels, and also the casting operation would not necessitate careful watching. In the production of alloy steel you are usually making a great variety each day, while in steel castings the melter on the furnace becomes so accustomed to the work that no time is wasted by sending samples to the chemical laboratories for analyses. Of course you appreciate that an analysis for carbon, manganese, sulphur, phosphorus and silicon consumes from 30 to 45 minutes and during this time the power is on the furnace. It is quite true that the metal is usually poured hotter for castings than alloy steel, though I will say that many times we have poured special heats of steel at a temperature higher than that necessary for castings. A fracture test is usually all the foundryman requires to determine his carbon, hence he saves power and time required for analysis and additions, and we have estimated this power saving would be 50 kilowatt-hours per ton for steel castings over alloy steels.

MR. J. B. NORDHOLT.—I would like to refer to the various papers that have been read in just a general way. I think that not only our company but most of the converter and crucible companies have been watching the electric furnace

for a number of years with much interest and since listening to the papers this morning, I am more confused than at any time in recent years, especially as each speaker has referred to the fact that the electric furnace is not a cure for all foundry troubles. I think one speaker referred to the fact that steel of any analysis could be sold because of the unprecedented demand. We all know that in a sense this is true. On the other hand, most of the electric furnaces, as Mr. Clark has stated and I believe is true, are being operated with an acid lining and are not attempting to refine; therefore they are not getting the best results obtainable from this type of furnace. Is this not due to the prohibitive cost of basic operation? I thought perhaps, that the remark that any steel could be sold was a sort of a reflection on converter steel. If so, what would be the quality of acid electric steel? The remark was also made that the electric furnace produced cheaper steel and it appealed to me, after discussing this with various foundrymen, that perhaps the demand for steel castings at the present time was working to the advantage of the electric furnace more than the converter. The cost of installation for electric furnaces is very high; in many cases, for equal capacities, five and six times that of converter installations; and when the electric furnace salesmen go out to sell their goods they are not offering the buyers anything better and are simply laying particular stress on the fact that there are great possibilities in electric furnace practice. Yet, apparently, it is not any easier to refine metal by that process, because if it were, more people would be doing it. Then the statement was made, that in five years from now the present furnaces would be antiquated, and if that is the case, what inducement is there for us to buy a furnace that in five years must be abandoned? All these statements put me in the position where I am wondering if it would not be advisable to continue along our present lines, using the converter until such a time as the electric furnace has reached that point of efficiency which can be absolutely proven and present troubles eliminated entirely.

Mr. E. B. Clark.—The gentleman has just quoted me as stating that most of the electric steel foundries are using acid

linings. I did make that statement, but I qualified it; I don't believe it is a fair statement. The electric furnace is not a cure for all troubles, but is there any other cure? I think you will agree that the electric furnace will help some of the troubles and that brings to my mind another advantage which I don't think has been properly brought out. Perhaps one of the reasons for the electric furnace requiring more intelligent supervision is that it is newer. Mr. Dixon had the fortunate experience of getting an ordinary laborer to run the furnace without any trouble, but he did not mention the fact, which undoubtedly is true, that he helped that man a great deal. Intelligent supervision is necessary for the electric furnace, but after it has been used for the same length of time for the same methods, a standard furnace practice will undoubtedly be established, and this will be worked out in much the same way that other problems in the foundry have been solved.

Mr. J. D. Nordholt.—I want to apologize to Mr. Clark for misquoting his paper. I stated that the majority were running their furnaces with acid linings. I did not mean to take his paper as an authority, but I have asked other men and they stated they were running acid, and when I asked for the reason, they said, "What is the use of operating basic, when we can buy all the good scrap we want?" The fact that led me to get up and make my remarks, was that all the speakers, with the exception of the last, referred to the fact that to get the proper results it required more skillful handling and that is one of the points that confused me. If we can get along with unskilled help, which, however, I do not admit—in the converter foundry, why should we, as I see it, change over to a process requiring skilled help and why should we, at the present time, install an electric furnace?

The Chairman, W. A. Janssen.—As a member of the papers committee, I will have to confess that we had a definite reason for inaugurating this electric furnace symposium. We realized that a large number of steel foundrymen have, for a great number of years, been in the same position as Mr. Nordholt—up in the air. We imagined that the symposium would produce the same effect on a good many others as it has

on Mr. Nordholt; in other words, it would bring about a lot of discussion on practical experience rather than the exploitation of the electric furnace. I think the thing that has been paramount in the minds of so many steel foundrymen regarding the installation of an electric furnace is very much the same as Mr. Booth referred to in his opening paper, and unfortunately some of the original exploiters of the electric furnace in their enthusiasm, led the steel foundrymen to believe that supervision was an unnecessary function of furnace operation; it was just a matter of putting it in at one end and taking the steel out at the other, but I believe every foundry using electric furnaces has come to realize that supervision of a high order is necessary, and it has been because of this realization that operators of other types of metal units have also been forced to know that their previous practices were not good, and this has resulted in better supervision and a better quality of steel by the converter and the open-hearth processes.

A MEMBER.—A statement was made a few days ago that any old steel could be sold. I would like to know what has been done to live up to the American Society for Testing Materials' requirements as to the physical and chemical composition of steel castings. We have been unable to buy steel castings to meet these requirements, which has led us to use forgings, more or less, when we could very readily have used steel castings; I would like to know of some place where we can buy steel which would come up to those requirements.

THE CHAIRMAN.—Are there any salesmen present? I think the gentleman has in mind the present condition of the country, in ordinary times the manufacturer insists on a more rigid inspection.

MR. J. B. NORDHOLT.—I have just one more word I want to say. I do not want to leave the impression that I am trying to reflect on the possibilities of the electric furnace. I am merely after information.

The Use of Titanium in the Manufacture of Steel Castings

By W. A. Janssen, Davenport, Ia.

Notwithstanding all that has been said concerning the harmful effects of phosphorus and sulphur in steel, the occluded oxides and gases, such as iron oxide, Fe_2O_3, and an undefinable oxide, probably FeO, free oxygen, nitrogen, and occluded slags, are the real causes of many of the troubles of the steel-maker. It is with the occurrence of these elements and their elimination that he is especially concerned. It has been definitely demonstrated that the presence of oxygen, and possibly nitrogen, in steel reduces its static strength, dynamic properties and abrasive values and increases its tendency to corrode. Today the presence of oxygen and oxides in steel is considered more harmful than even relatively large amounts of phosphorus and sulphur. In a measure the same is true of nitrogen, although the investigations in this direction have not been sufficiently complete and the results are variable and uncertain. Advanced methods of analysis allow the isolation and determination of both of these gaseous constituents. Unfortunately insufficient credence has been given to their existence.

Many analyses of steels will disclose an oxygen content of approximately 0.05 per cent. This may be compared with the analysis of other undesirable constituents, such as phosphorus and sulphur. It must, however, be borne in mind that it is not the nascent oxygen itself which causes the harm, but rather the compounds which it so readily forms. The presence of 0.05 per cent oxygen may mean, if it is combined with the iron, the existence of 0.22 per cent of oxide of iron, an amount sufficient to materially effect the quality of the metal. Bessemer or converter steels contain the largest amount of occluded oxides, with the open-hearth steels next (the steel made by the basic process contains more than that made by the acid process), crucible steels next, and electric steels last. The steels made

in the electric furnace are practically free from oxides. It will be seen that the accepted range of the quality of steels, from the oxidizing bessemer process to that of the electric furnace, is determined by the freedom from occluded oxides.

It is an established fact that the presence of oxides in steel materially accelerates corrosion. All impurities in steel are electro-negative as compared with iron except the oxide of iron which is electro-positive. The difference in potential set up between this couple in the presence of moisture or dilute acids causes the steel in the proximity of the oxide areas to corrode rapidly.

The reason for the occurrence of cracks in steel castings is an oft debated question. Aside from cases where no consideration has been given to the proper distribution of metal in the design of the casting, unduly restricting the cooling and shrinkage, the cause for cracks has been considered to be due to red-shortness. These defects usually are found where the metal, in cooling from its liquid through its plastic or viscous state, due to its lack of stability, cracks under pressure or restricted shrinkage. Sulphur, to which is usually attributed the cause for red-shortness, is generally given credit as being the cause of the cracks. Even when the casting has been designed properly and made with a sulphur content of not over 0.025 per cent, these same cracks appear periodically. An examination of these cracks, even with this abnormally low sulphur content, disclose a crystalline fracture. It has been observed that when the furnace is again brought to a normal condition of operation and the amount of occluded oxides reduced, these cracks again disappear. It is known that this occluded oxide of iron also has the property of causing red-shortness. Furthermore, it has been observed that in an over-oxidized metal, in the range of the plastic state of cooling, the liability of the occurrence of cracks is greatly increased. That these cracks occur in castings which are uniformly sound and free from blow-holes throughout, seems to indicate that the normal additions of the deoxidizers, ferro-silicon and ferro-manganese, which are governed by specifications, do not entirely free the metal of its oxides. The introduction of these oxides into the metal is primarily dependent upon furnace manipula-

tion. In the bessemer process it may be due to over-blowing, in the open-hearth process to the use of too sharp a flame, the admission of too much air for combustion or the use of too much ore in refining. Even in the electric furnace, which is supposed to refine steel in a neutral atmosphere, oxides find their way into the metal due to the inability to maintain a calcium-carbide slag, which is the primary function of an electric furnace in the production of deoxidized steel. With present-day furnace operation, which at best is variable and manipulated by rule-of-thumb, the steelmaker must have at his command a positive deoxidizer or cleanser to augment the ordinary deoxidizers such as ferro-silicon and ferro-manganese.

With the advent of ferro-alloys of silicon and manganese containing high percentages of the active elements came the hope of an assured unform quality of steel. As deoxidizers, modern ferro-alloys are efficient in a measure, but have certain limitations. It is the function of these deoxidizers to combine with the occluded oxides; the resulting products rise and become a part of the slag. Unfortunately the temperature of the metal and its resultant fluidity do not always permit these deoxidizers to complete their cycle and rise to the slag; they are entrapped as inclusions and the occluded gases are not entirely deoxidized. The known presence of oxides in excess of the amount which can be deoxidized by the usual additions of ferro-silicon and ferro-manganese is not permitted because of specification tolerances for manganese and silicon content.

Silicon Not a Strong Deoxidizer

Silicon, comparatively speaking, is not a strong deoxidizer, and when it is added to steel a portion of it remains in the steel either as an alloyed constituent, or the products of its oxidation may remain as inclusions. The usual analyses for silicon do not disclose whether or not the silicon is present in the steel as an alloyed silicide, as silica or as the silicate. Even if the silicon manifest itself as a silicide, showing a high silicide percentage, a wild heat is apt to result, requiring the use of a further deoxidizer (aluminum) when pouring the molds. In conjunction with manganese, double silicates of iron and manganese frequently are formed. Such a constituent

may contribute to excessive segregation, although singularly, a dirty steel often discloses very little segregation.

The oxide of manganese formed with the use of ferro-manganese as a deoxidizer, although of low specific gravity may not rise and become a part of the slag; instead it becomes entrapped and reacts with the carbon of the steel to form carbon monoxide. The chemical formula is as follows:

$$MnO + C = Mn + CO$$

Chemical analyses do not disclose in what combination manganese is present in the steel, whether as a sulphide, carbide or oxide. If present as a sulphide or carbide, it may manifest itself as a segregated area of weakness. If present as the oxide of manganese, it exists in its most deleterious form. The existence of oblong surface blow-holes may be said to be due directly to the presence of manganese oxide, indicating the fact that the metal has not been thoroughly deoxidized. As previously stated, the manganese-oxide reacts with the carbon of the steel to form carbon monoxide, which, by expansion, will be forced to the surface of the casting, resulting in the formation of oblong blow-holes. This same type of blow-hole may exist due to the reaction of the carbon of the steel with the iron oxide. Blow-holes may also exist in other parts of the casting. Usually they are either spherical or lenticular in shape and generally they are due to imperfect molding, imperfect venting, damp sand, or the entrapping of air or aqueous vapor formed by the hot steel.

The Effect of Nitrogen

The actual effect of nitrogen in steel is still a moot question. It is only comparatively recently that any research has been done on this subject, the most of which has been performed by European metallurgists. In a measure their findings have been incomplete and their results somewhat variable. This may be due to a variance in the methods of analysis. Some investigators, even after synthetic incorporation of nitrogen, on analysis find less nitrogen present than others find in the usual product of the furnaces. By some it is held that the effect of nitrogen in steel is much the same as phosphorus, in that

it causes cold-shortness and brittleness. Analysis of steel for nitrogen seems to indicate that the greatest amount is found in bessemer steel, with smaller amounts in the open-hearth product and still less in steel made in crucibles and electric furnaces. The amount present in the latter processes is dependent on the nitrogen content in the stock charged. If the presence of nitrogen be determined and if it is considered undesirable, its elimination or reduction can only be affected by titanium to form stable titanium-nitride; ferro-silicon, ferro-manganese and even vanadium having no affinity for nitrogen.

To augment the deoxidizing effect of ferro-silicon and ferro-manganese, steelmakers have resorted to the extensive use of aluminum. Aluminum is the most powerful deoxidizer known. Nevertheless its use in quantity is a menace in that the resultant product of oxidation—alumina—is a viscious oxide which has a melting point at 2,010 degrees Cent. This material is infusible at the temperature of the molten steel and also renders other slags infusible. Because of its physical characteristics, the alumina, as formed frequently, does not find its way to the slag, but remains entrapped in the steel as shot or streak inclusions.

Titanium, until a comparatively few years ago looked upon as one of the rare metals, undoubtedly is one of the most powerful deoxidizers and denitrogenizers known. Titanium as an element is a hard, brittle material having a grayish silver luster. It has a melting point of about 2,300 degrees Cent. Titanium burns energetically in oxygen and is the only known element which "burns" in nitrogen. It is widely distributed in nature, usually as a dioxide in rutile, brookite, anatase and in some clays and as ferrous-titanate in titaniferrous iron ores. The knowledge of its effects has long been classic. The use of titanium, however, was prohibitive because of its high cost. Titanium at the present time may be obtained as one of the ferro-alloys.

The ferro-alloys of titanium, in general, are produced by two distinct processes, by the electric furnace process as developed by the dean of titanium investigators, Auguste F. Rossi, and by Dr. Hans Goldschmidt by his well-known alumino-

thermic process. Each of these alloys have their particular application, the function of both, however, being the same. The ferro-alloy, made by the Rossi process, consists essentially of microscopic particles of titanium-carbide held in a matrix of gray iron. Its analysis is as follows: Titanium, 15.79 per cent; carbon, 7.46 per cent; silicon, 1.41 per cent; manganese, 0.11 per cent; phosphorus, 0.05 per cent; sulphur, 0.08 per cent; iron, by difference, 74.30 per cent. The analysis of the alloy made by the Goldschmidt-Thermit process is as follows: Titanium, 22 per cent; manganese, 0.50 per cent; carbon, less than 0.10 per cent; aluminum, 5 to 8 per cent; phosphorus, 0.10 per cent; silicon, 0.75 per cent; sulphur, 0.02 per cent; iron, by difference, 70.31 to 73.31 per cent.

The product made by the thermit process, it will be noted, is peculiar because of its aluminum content and freedom from carbon. For this difference, as compared with the Rossi product, some claims have been made which in their entirety have not been substantiated.

The chief value and merit of titanium lies in its positive action in the removal of the occluded oxides, nitrogen and entrapped slags, due to the fusibility of titanic oxide as formed and its greater stability as compared with iron oxide. Its function is further augmented by the increased fluidity due to the increased temperature because of the exothermic reaction, thereby permitting freer movements of the oxidized products to slag.

How to Use Titanium

The present-day method of using of ferro-titanium is to augment the incompleted cycle with ferro-titanium after the other deoxidizers have been added. These may be added in the ladle, or in the furnace before tapping. After the titanium has been added, it is *imperative* and *essential* that the ladle be held from five to 10 minutes before pouring in order to allow time for the completion of the reactions. No fear need be had of the chilling of the metal inasmuch as the temperature is raised appreciably, due to the exothermic reaction. It is essential that the titanium be not added until after the additions of ferro-silicon and ferro-manganese have been made. On

account of the greater affinity of titanium for oxygen, the ferro-silicon and ferro-manganese must be given an opportunity to complete their primary deoxidation, thereby eliminating selective oxidation. It is also essential that the ferro-titanium be added as soon thereafter as possible so that the alloy does not become a part of the slag and there perform its deoxidation. Ferro-titanium has its application as a deoxidizer and cleanser in the crucible, converter, open-hearth and electric furnace processes of steel manufacture, as well as in the cast iron and malleable iron industries. If ferro-titanium be used in the crucible process, it may be added as a part of the charge, being placed well down toward the bottom of the pot, or added after the manganese addition has been made. Because of its intensified affinity for occluded gases and cleansing action on inclusions, its use extends to the metallurgical processes for the more common non-ferrous alloys and also to the rare metals.

Titanium in combining with oxygen to form titanium-oxide, with a heat of formation of 215,000 calories, acts as a flux for silicates and other slags, which normally would remain in the slag, rendering them sufficiently fluid to rise through the metal and pass into the slag. Titanium at about 800 degrees Cent., combines with nitrogen to form the stable titanium-nitride which usually finds its way to the slag. Microscopic examination, however, sometimes reveals the existence of occluded tiny, hard, pink crystals of titanium-nitride, which, however, are less harmful in effect than the occluded nitrogen. With all these beneficent effects, its use beyond a certain amount is of no avail and in a measure harmful.

Does Not Alloy with Steel

Titanium, singularly, does not form alloy steels as do the other deoxidizers, such as silicon, manganese and vanadium. Many analyses of titanium treated steels do not reveal a titanium content higher than 0.025 per cent. With the use of alloys containing more than 10 to 15 per cent titanium, the results are not as effective, owing to the slower rate of solution. Much has been said and written about the relative efficiencies of ferro-carbon-titanium and the carbon free alloys, with par-

ticular reference to their comparative solubilities because of the carbide content. The carbon in the ferro-carbon-alloy in excess of that present as titanium-carbide is present almost entirely as graphitic carbon, which in all probability does not affect the rate of solution. If there be an effect, in all probability it is offset by the lower rate of solution of the alloy of higher titanium content. The carbon free alloy has a special application to the lower carbon steels of definite carbon content which might be increased by the use of the carbon alloy. Its use, however, involves the presence of aluminum with possible Al_2O_3 contamination.

The amount of ferro-titanium used depends in a measure on the kind of steel to be treated. In rail steel, an addition of 13 pounds of the 15 per cent alloy per net ton, representing a metallic titanium addition of 0.10 per cent is satisfactory. In the use of titanium for steel castings the addition of 1½ to 2 pounds per 1,000 pounds of metal charged, in addition to the usual ferro-silicon and ferro-manganese additions is usually sufficient to deoxidize the steel. The amount of ferro-titanium added, however, should be dependent on the quantity of impurities which are to be removed and the process of manufacture.

Some claims have been made for the use of titanium in excess of the amounts necessary for deoxidation in the elimination of sulphur and phosphorus, or at least to convert them into compounds having less harmful effects. It has been stated that the sulphur is eliminated as a sulphide or as a sulphocyanide of titanium and that the phosphorus passes to the slag as titanium-phosphate. These claims in their entirety, however, have not been substantiated.

Blow-Holes in Soft Steel

In the low carbon or soft steels the presence of blow-holes, occluded gases and slag inclusions is greatly aggravated due to the metal being longer subjected to the oxidizing action of the flame or blast or because of its being necessary to increase the temperature of the metal for successful and economic teeming. Soft steels, because of this low carbon content, cool more rapidly after having reached a point of initial solidification,

thereby the occluded gases are not afforded sufficient time to escape before the metal has reached its plastic state. Titanium, properly apportioned in conjunction with proper treatment, will cleanse and purify the metal. With the use of titanium in the higher carbon steels, it has been found that these steels are softer and less brittle than steels of the same carbon in which titanium has not been employed due in all probability to the more uniform distribution of the ferrite network.

In alloy steels, where special alloys such as nickel, chromium and manganese are added because of a special function, the quality and properties of the metal are improved by the further addition of titanium for the elimination of the oxides of nickel and chromium, both of which contribute to the brittleness of steel. The manufacture of manganese steel is greatly benefited by the proper addition of titanium. With the use of this alloy, the manganese is disseminated uniformly, resulting, with proper heat treatment, in a tough, homogeneous product.

Vanadium in Steel

During the past few years specifications for steel castings for specific designs and service have demanded the use of vanadium. Although the presence of vanadium in steel undoubtedly has improved its physical properties, it is questionable whether vanadium manifests its maximum efficiency in plain carbon steels, especially within the carbon range of steel castings. The vanadium addition is calculated as an alloying constituent, the amount present in the final product being within three or four points of the desired calculated content. Vanadium has manifested its greatest value when used in conjunction with chromium and nickel as a deoxidizer. Vanadium is only 70 per cent as efficient as titanium and has but little effect on nitrogen.

It will be seen that with proper proportioning of the alloy and proper manipulation of the heat, steel is improved in density, strength, toughness and durability, when titanium is used. This improved quality of product is not due to any direct or alloying effect of titanium, but rather to its value as a deoxidizer and cleanser in removing harmful occluded gases and slags. It must not, however, be looked upon as a cure-all

to rectify the evils of poor stock selection and bad furnace practice, but rather to make good steel better by further augmenting the incomplete reactions of the best present-day deoxidizers and clarifiers.

When Steel Becomes Stronger

With the elimination of the occluded oxides and slags, steel, because of its increased density and homogenity, has improved static and dynamic properties. A comparative test of 20 untreated and treated heats showed an increase in the ultimate strength of approximately 15 per cent with no reduction in elasticity and contraction. A remarkable endurance test was conducted by Enrique Touceda on untreated and titanium-treated steels of practically the same chemical composition. The test was conducted in a Wright-Souther machine at a fibre stress of 38,872 pounds. The untreated steel withstood 2,676,000 revolutions at this pressure, whereas the titanium-treated steel withstood 18,274,900 revolutions at pressures varying from 38,872 up to 45,939 pounds fibre stress.

Many tests made on rails and machine parts indicate the ability of titanium-treated rails to withstand shocks and abrasion, the life of gears and rails being about 50 per cent greater than those made of untreated steels. In a comparative test on gears it was found that titanium-treated gears, although made of 0.20 per cent carbon steel, too soft to be ordinarily considered acceptible for machine parts, outlasted untreated steel gears of the same composition three to one.

Steel, instead of being a homogeneous chemical compound, must be considered as a hetereogeneous mechanical aggregate of crystals of definite shapes, welded onto the adjacent crystals. The efficacy of these welds and the ultimate strength of steel against fracture, rupture and fatigue is directly dependent upon the absence of segregated impurities which segregate at the boundaries of these crystals. With the elimination of these occluded impurities by the use of titanium these crystals are brought into a closer weld with one another. Segregation is further reduced by the elimination of the occluded oxides, which, because of lower specific gravity, rise and form a path for the selective segregation of phosphorus, sulphur and the crystals of higher carbon constituency.

With the present high cost of ferro-manganese and the attendant shortage of supply, the writer has carried on some extensive experiments to conserve his ferro-manganese without affecting the quality of the product. Realizing that the manganese present in steel castings contributes only indirectly in increasing the strength, the purpose of these experiments was to reduce the manganese from 0.75 to 0.50 per cent. To be assured of the same strength, the usual ferro-manganese addition was reduced from 320 pounds for a 20-ton heat to 200 pounds and the ferro-titanium addition increased from 60 to 120 pounds. Tensile tests for these heats showed an average ultimate strength of 68,000 pounds, for a 0.20 per cent carbon steel, with an average elongation of 30 per cent and a reduction of area of 47 per cent.

It can be well appreciated that the use of ferro-titanium in making steel castings is no longer an innovation, but rather a necessity to offset the vagaries and shortcomings of present-day practice, thereby making good steel better.

FIG. 1—COMPLEX SLAG INCLUSIONS CONTAINING OXIDES, SULPHIDES AND SILICATES

Magnified 200 diameters

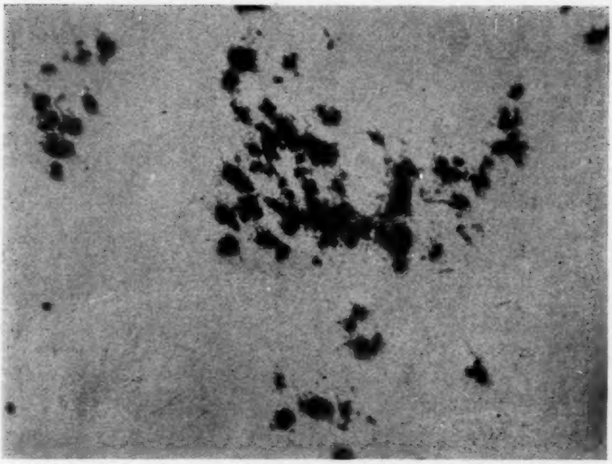

FIG. 2—GROUP OF ALUMINA PARTICLES IN PLAIN STEEL
Magnified 400 diameters

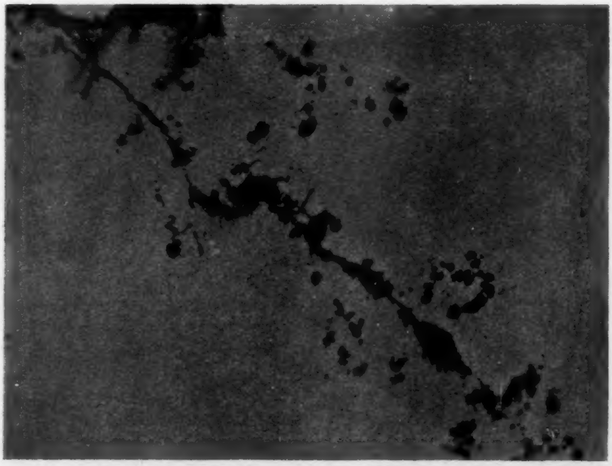

FIG. 3—CRACKS EXTENDING THROUGH SMALL GROUPS OF ALUMINA INCLUSIONS IN TITANIUM-TREATED STEEL TO WHICH ALUMINUM ALSO WAS ADDED
Magnified 200 diameters

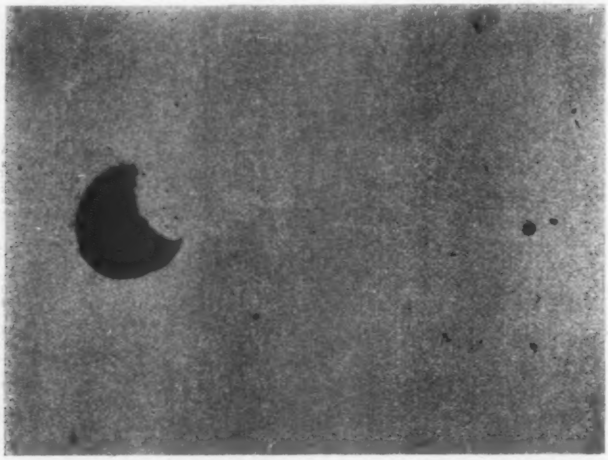

FIG. 4—TYPICAL SILICATE OR SLAG INCLUSION IN PLAIN STEEL
Magnified 200 diameters

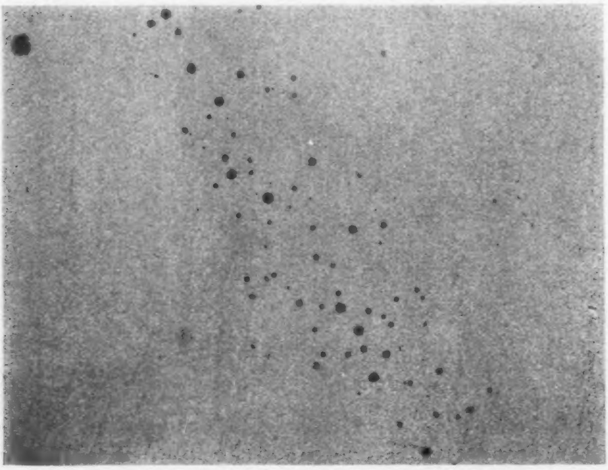

FIG. 5—STREAK OF FULL PARTICLES OF OXIDES IN PLAIN STEEL
Magnified 200 diameters

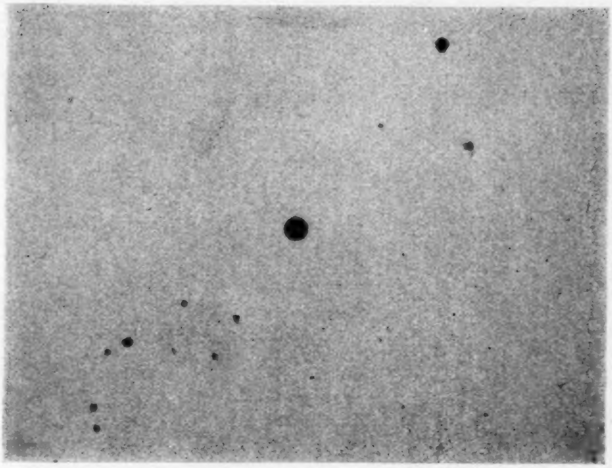

FIG. 6—TYPICAL SMALL SILICATE OR SLAG INCLUSIONS IN TITANIUM-TREATED STEEL
Magnified 200 diameters

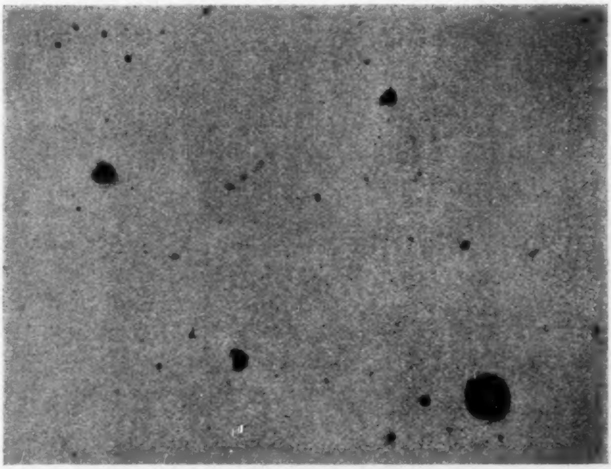

FIG. 7—INCLUSIONS OF ALUMINA, SILICATES AND SULPHIDES IN PLAIN BESSEMER STEEL
Magnified 200 diameters

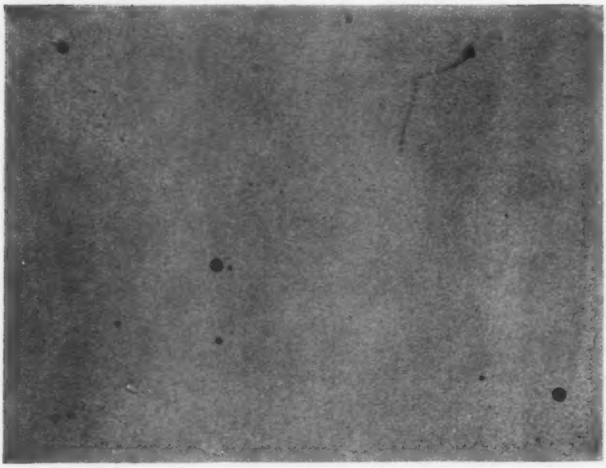

FIG. 8—TYPICAL SMALL GROUPS OF SILICATES AND SULPHIDES IN TITANIUM-TREATED STEEL

Magnified 200 diameters

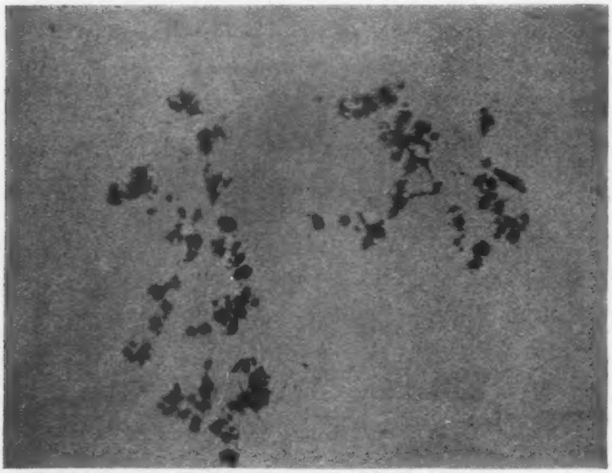

FIG. 9—GROUP OF ALUMINA PARTICLES IN PLAIN STEEL

Magnified 200 diameters

Discussion—The Use of Titanium in the Manufacture of Steel Castings

THE CHAIRMAN, W. A. JANSSEN.—Is there any discussion? Mr. Secretary, will you kindly read the written discussion by Mr. N. Petinot?

MR. N. PETINOT.—I have read Mr. Janssen's paper with much interest, and agree with him entirely that the addition of titanium to steel properly made, results in advantage. This is readily observable in those grades of steel which are reduced to sections, as is done for billets, sheets, wires, etc. I notice that Mr. Janssen says that "Titanium singularly does not form alloy steels as do the other deoxidizers, such as silicon, manganese and vanadium."

It is, however, possible, in my experience, to make steel with a titanium content, and that without an excessive loss of titanium, if the carbon free alloy is used; but if the ferro-titanium used has a carbon content, the titanium being in as a double carbide of iron and titanium, it is impossible to get any appreciable titanium content in the steel, even when figuring on a large loss.

The same has also been found true in the manufacture of vanadium steels, and it is for this reason that carbon-free ferro-vanadium is always used, instead of the grade with a carbon content, such as was imported a few years ago from abroad in which the vanadium is present as a carbide of vanadium, or rather as a double carbide of iron and vanadium.

Mr. Janssen states also that "The amount of ferro-titanium used depends in a measure on the kind of steel to be treated," and that for rail steel an addition of 13 pounds of a 15 per cent alloy per net ton, representing a metallic addition of 0.10 per cent, is satisfactory, while for steel castings the addition

of $1\frac{1}{2}$ to 2 pounds of the same alloy per ton of metal charged is usually sufficient to deoxidize the steel.

I think this statement requires some explanation to be clearly understood. Take, for example, the standard specifications for open-hearth rail steel and steel castings, which are respectively as follows:

Rail Steel

	Per Cent
Carbon	0.65 to 0.95
Manganese	0.60 to 0.90
Silicon	0.10 to 0.20

For Open-Hearth Steel for Castings

	Per Cent
Carbon	0.17 to 0.40
Manganese	0.50 to 0.75
Silicon	0.25 to 0.35

It would seem from these specifications that a heat of steel made for rails should finish less oxidized than a heat of steel for castings, and consequently should not require more or, any way, not six times the amount of, deoxidizer than the steel for castings.

Mr. Janssen also mentions in the same paragraph that vanadium is a deoxidizer. I do not agree with him on this point. It does not necessarily follow that the loss of from 10 to 25 per cent of vanadium resulting from the addition of ferro-vanadium to steel, indicates a deoxidization of the steel. The same phenomenon is observable when ferro-chromium is added to steel. Will Mr. Janssen say, therefore, that chromium acts as a deoxidizer? I think that it is more generally believed among metallurgists that the loss of vanadium is due to the fact that small pieces of the ferro-vanadium become coated with slag and are wasted in the slag by floating to the top of the metal in the ladle.

Vanadium added as a constituent to various grades of steel gives them some very good properties, but if considered as a deoxidizer, would certainly be a very expensive and poor one.

Mr. Janssen states, in the paragraph headed *Vanadium in Steel,* that "Vanadium is only 70 per cent as efficient as titan-

ium." I cannot imagine what proofs Mr. Janssen has for this statement, since, for reasons previously given, I personally do not think that vanadium is a better deoxidizer than chromium, for instance, which is lost in about the same proportion when added to molten steel.

I agree perfectly with Mr. Janssen that vanadium steel, as all other alloy steel, when properly made, can be improved by ferro-titanium as the final addition. I do not, however, agree with Mr. Janssen when he says that he can, by the use of ferro-titanium, reduce his manganese content from 0.75 to 0.50 per cent and get the same physical qualities.

In making heats of steel in acid or basic open-hearth furnaces, we all know the fluctuation in sulphur that we get from heat to heat when the final test piece is analyzed. We also know from experience that when heats are higher in sulphur and low in manganese, cracks appear more freely on the castings, manifesting the phenomenon called *red shortness*.

Steel makers also know how hard it is to aim the right percentage of manganese content in the steel, and many of us have found from experience that occasionally while aiming for a manganese content on the high side of the specification, the final analysis of the heat shows it to be on the low side, or that the heat has a low manganese content. If Mr. Janssen can, by the use of ferro-titanium, reduce his manganese from 0.75 to 0.50 per cent, I would ask him what is the low limit that he gets when aiming for 0.50 and if he has found a way to get exactly the amount of manganese he wishes. He will certainly help us very much by stating how this can be done.

I would also ask him what limits of sulphur he usually gets in his grades of steel with a manganese content of 0.50 per cent, particularly in acid steel. I have had some experience making ingots of acid steel forgings in which I tried to reduce the manganese content on account of the high price of ferro-manganese. Such grades of steel averaged in chemical compositions as follows: Carbon, 0.40 to 0.65 per cent; manganese, 0.60 to 0.75 per cent, and silicon, 0.22 to 0.25 per cent.

I treated such steels with 8 pounds per short ton of an alloy containing 15 per cent of titanium, being the same alloy

as that used by Mr. Janssen, and each time the manganese was around 0.45 to 0.50 per cent and the sulphur about 0.04. The ingots always started to manifest *red shortness* by cracking at the rolling mill, and I assumed that this *red shortness* was produced mostly by the high sulphur and low manganese content, and not by any oxide left in the steel; since such steels had a high silicon content and had been treated with titanium as a final deoxidizer and cleanser.

To resume, what I wish to make clear is that I do not think that it is possible safely to diminish the manganese content of steel for castings from 0.75 to 0.50 per cent, as stated by Mr. Janssen, by merely using 6 pounds of 15 per cent ferro-titanium per ton of steel, and that if it is possible, the titanium has nothing to do with it. However, such steel, if treated with titanium will be certainly found cleaner and freer from segregation, regardless of the manganese content.

I would appreciate if Mr. Janssen would mention the complete chemical analysis of the heats of steel treated with titanium, and with a carbon content of 0.20 per cent. The physical results which he mentions are common to such ordinary grades of steel properly annealed.

THE CHAIRMAN, W. A. JANSSEN.—Mr. Petinot says, "I notice that Mr. Janssen states that 'Titanium singularly does not form alloy steels as do the other deoxidizers, such as silicon, manganese and vanadium'." That is the moot question, but I still maintain that if the titanium be present, its function is not the same as manganese, vanadium, etc., and up to the present time no alloying function has been found for the presence of titanium which might be present in excess of 0.25 per cent. I agree with Mr. Petinot that if it should later be found that if this excessive content has merit, it would then, in all probability, be more efficacious to use carbon-free titanium than the more common alloy of a ferro-carbon-titanium, because it is well known that the best results in the use of vanadium as an alloy are with ferro-carbon-vanadium. Referring to my statement that "the amount of ferro-titanium used depends in a measure on the kind of steel to be treated, and that for rail steel an addition of 13 pounds of a 15 per cent

alloy per net ton representing a metallic addition of 0.10 per cent, is satisfactory, while for steel casting the addition of 11.5 to 12 pounds of the same alloy per ton of metal charged is usually sufficient to deoxidize the steel," I don't know whether I did not make myself clear in the paper, but I still maintain that I am correct and also that Mr. Petinot is correct; but what I want to present is this: That the amount of titanium added depends upon the specific application of the steel with a special reference to rails, and I will again quote from my paper:—"In rail steel an addition of 13 pounds of the 15 per cent alloy per net ton, representing a metallic titanium addition of 0.10 per cent is satisfactory," and this is to offset segregation, a condition which need not in general be considered in the use of ferro-titanium as the deoxidizer for making steel for castings; it may be very interesting to know that it requires a definite percentage of ferro-titanium to perform the double function of serving as a deoxidizer and offsetting segregation, 6.6 pounds of 15 per cent ferro-titanium will give a titanium content of 0.05; 10 pounds gives a titanium content of 0.075; below, or at this point, we cannot say with certainty, we have begun to eliminate segregation, and it requires a point equivalent to 13.2 pounds per ton to feel assured that the titanium has performed a double function as a deoxidizer and to offset segregation. I trust I have covered that point very thoroughly.

Mr. Petinot says, "Mr. Janssen also mentions in the same paragraph that vanadium is a deoxidizer. I don't agree with him on that point. It does not necessarily follow that the loss of from 10 to 25 per cent vanadium resulting from the addition of ferro-vanadium to steel indicates deoxidation. The same phenomenon is observable when ferro-chromium is added to steel. Will Mr. Janssen say, therefore, that chromium adds as a deoxidizer? I think it is more generally believed among metallurgists that the loss of vanadium is due to the fact that small pieces of the ferro-vanadium become coated with slag and are wasted in the slag by floating to the top in the ladle." Knowing Mr. Petinot as I do, and with all due respect to metallurgists generally, I know each one has his little pet theory and I happen to know that Mr. Petinot does not believe

that vanadium is a deoxidizer; but I think it is generally held by all metallurgists that vanadium is a deoxidizer and the reference to ferro-chromium is not comparable. I believe metallurgists hold today that both nickel and chrominm are looked upon as alloying constituents and not as deoxidizers, and ferro-vanadium as a deoxidizer.

Quoting again from Mr. Petinot's discussion: "Mr. Janssen states in a paragraph headed *Vanadium in Steel* that vanadium is only 70 per cent as efficient as titanium. I cannot imagine what proofs Mr. Janssen has for this statement since, for reasons previously given I personally do not think that vanadium is a better deoxidizer than chromium for instance, which is lost in about the same proportion when added to molten steel." That, of course, refers to the comment I just made, but I still maintain that vanadium is not as efficient a deoxidizer as titanium. The loss with the use of titanium may be anywhere between 10 to 30 per cent.

Mr. Petinot says further: "I do not, however, agree with Mr. Janssen when he says that he can, by the use of ferro-titanium, reduce his manganese content from 0.75 to 0.50 and get the same physical qualities. In making heats of steel in acid or basic open-hearth furnaces we all know the fluctuation in sulphur we get from heat to heat when the final test piece is analyzed. We also know from experience that when heats are high in sulphur and low in manganese cracks appear more freely on the castings, manifesting the phenomenon called *red shortness*." As stated in the original paper, with the shortage in the supply of ferro-manganese and the increased cost, and in order to conserve our supply, I started on some radical experiments, because I realized for a long time that there has been agitation all over the country among steel foundries along these lines. I will quote from my paper: "Realizing that the manganese present in steel castings contributes only indirectly in increasing the strength, the purpose of these experiments was to reduce the manganese from 0.75 to 0.50 per cent. To be assured of the same strength, the usual ferro-manganese addition was reduced from 320 pounds for a 20-ton heat to 200 pounds and the ferro-titanium addition increased from 60 to 120 pounds. Tensile tests for these heats showed an average

ultimate strength of 68,000 pounds for a 0.20 per cent carbon steel, with an average elongation of 30 per cent and a reduction of area of 47 per cent." It occurred to me that if I could substitute some other material, even though possibly of the same commercial value, I would conserve my supply of ferro-manganese. The best evidence of the possibilities and results of these experiments were the physical tests themselves; we saw absolutely no change whatever in the physical properties of the steel with the manganese content of 0.50 per cent. I might say, however, that I keenly appreciate that some others have tried to duplicate my results with indifferent success.

Quoting Mr. Petinot's discussion: "I would also ask him what limits of sulphur he usually gets in his grades of steel with a manganese content of 0.50, particularly in acid steel. I have had some experience in making ingots of acid steel for forgings in which I tried to reduce the manganese content on account of the high price of ferro-manganese." Coming from a basic shop I cannot speak with certainty on what might occur in acid steel, but in our particular practice the sulphur content rarely if ever goes over 0.025. We are very careful in the selection of our materials, especially our pig iron, not accepting the usual basic pig iron specifications of 0.05; we are insistent that the sulphur be not over 0.035 per cent for we feel that 0.035 per cent may mean 0.05 and 0.05 may mean 0.07, but the usual method of sulphur analysis for pig iron will not entirely isolate the sulphur content, carrying it over in the usual method as hydrogen sulphide; but it does occur that some of the sulphur remains in the pig iron as an organic sulphide, in all probability a methyl sulphide which does not permit of its being broken down. Mr. Petinot gives some figures: "Such grades of steel average in chemical compositions as follows:—Carbon, 0.40 to 0.65 per cent; manganese, 0.60 to 0.75 per cent, and silicon, 0.22 to 0.25 per cent.

"I treated such steels with 8 pounds per short ton of an alloy containing 15 per cent of titanium, being the same alloy as that used by Mr. Janssen, and each time the manganese was around 0.45 to 0.50 and the sulphur about 0.04. The ingots always started to manifest ***red shortness*** by cracking at the

rolling mill, and I assume that this *red shortness* was produced by the high sulphur and low manganese content, and not by any oxide left in the steel; since such steels had a high silicon content and had been treated with titanium as a final deoxidizer and cleanser." In fairness to ourselves, I must say that I know something about this test and the ferro-titanium was not added to the steel in the ladle as is the usual practice, but as an experiment it was added in the furnace before tapping and in the slab form. It had been previously demonstrated several years ago that the addition of ferro-titanium in the furnace was not satisfactory. However, I question very much whether Mr. Petinot is quite correct in stating that it always manifested *red shortness* by cracking at the rolling mill, and I question, or I assume, that the *red shortness* was on high sulphur and low manganese content. He refers to a sulphur content of 0.04 which is well within the limits of commercial specifications for sulphur. The low manganese to which he refers, 0.45 to 0.50 per cent, is the exact maximum specification for most rolled sections. I am wondering, not knowing definitely, what Mr. Petinot means by high silicon content, if the condition of sulphur and a high silicon content, which we all know produces *red shortness* might not have been due to the existence of 0.04 sulphur and a high silicon content, which we all know produces cracking at the mill. Referring again to the experiments, I question very much, in fact I feel almost certain, that the use of titanium played no part in the deoxidation, and in all probability that the condition of the metal was such that the lower limits of 45 to 50 points of manganese had not sufficiently deoxidized the steel and that the resulting condition was not attributable to the use of ferro-titanium.

Mr. Petinot suggests: "I would appreciate if Mr. Janssen would mention the complete chemical analysis of the heats of steel treated with titanium, and with a carbon content of 0.20 per cent. The physical results which he mentions are common to such ordinary grades of steel properly annealed." It is our practice to make a basic steel having a carbon content between 0.18 to 0.22 per cent, and about 0.30 to 0.35 per cent silicon; our phosphorus is rarely over 0.01 and sulphur not over 0.025

per cent. Prior to these manganese reduction experiments, our specifications for manganese were the requirements of railroad service, manganese not to be over 0.75 per cent. I stated that the ultimate strength was 68,000 pounds, and Mr. Petinot says these results are common if the steel is properly annealed. I feel that he made a slight error as I do not think it is general practice to expect an ultimate tensile strength of 68,000 pounds, unless it is on the theoretical basis that we would have 38,000 pounds for the iron content, 20,000 pounds for the carbon constituency and 4,000 pounds for the phosphorus, which I believe in all is about 62,000 pounds, which was our usual ultimate strength for low carbon steel before the use of ferro-titanium as a cleanser and deoxidizer. Now if there are any points that anybody recalls in Mr. Petinot's discussion that I have not answered I would be glad to have them brought to my attention.

Mr. L. Selmi.—I have the following written discussion which I would like to present: I have read the interesting paper by Mr. Janssen on "The Use of Titanium in the Manufacture of Steel Castings", and I feel that it may be well for me to enter into the discussion as I have made a number of observations along these lines. I do not care to call it research work, but it covers about 120 heats of acid open-hearth steel which was used in casting rolls. Of these 120 heats, 30 were cast straight, that is, no addition was made; 30 were treated with aluminum in the ladle in varying amounts of 4 ounces to 1 pound of aluminum per ton of steel; 30 were treated with Goldschmidt carbon-free-titanium alloy in varying amounts of from 2 to 4 pounds of alloy per ton of steel; 30 were treated with ferro-carbon-titanium from 3½ to 10 pounds of alloy per ton of steel. All of these heats were of acid steel made in 20-ton furnaces and the carbon varied from 0.50 to 1.10 and they were used in casting large rolls so that only one roll was obtained from a 20-ton heat. Our object in doing this was to find out the treatment which would enable us to make the best rolls free from suggestion and blow-holes, so great care was taken to keep a complete record of the heats as well as that of the working condition of the furnace.

The temperature of the steel was taken with a Simatco pyrometer at tapping time and also at casting from the ladle. In all of these heats without exception, the ladle was held for 10 minutes. We endeavored to vary the tapping temperatures with the analysis of the steel wanted, but for the purpose of showing what our results were in these experiments I will give you the average Fahrenheit temperature of the average steel as we observed it:

	Tapping temperatures from furnace deg., Fahr.	Casting from ladle deg., Fahr.	Difference, deg., Fahr.
1—No addition	2,850	2,770	80
2—Aluminum addition	2,840	2,780	60
3—Goldschmidt titanium addition	2,900	2,850	50
4—Ferro-carbon-titanium addition	2,940	2,780	160

The appearance of the rolls disclosed that those that had received no treatment and those that had been treated with Goldschmidt's titanium alloy were by far the best. Next in line were those treated with aluminum and the least success we had was with those treated with carbon-titanium.

The nature of the defects encountered in these rolls was that of pine tree crystal structures in pockets and numerous blow-holes which invariably settled on the upper part of the rolls. In all these castings a large, uniform sink-head was allowed for all the rolls, as we tried to have the same condition in each case as was consistent with practice. All these rolls were examined under the microscope, and a specimen taken from the same position in each case; these examinations revealed that in the first three categories very small amounts of slag inclusions were present. In the fourth category, besides all these small amounts of slag inclusions, there were noticeable blow-holes and pine tree structures which were surrounded by a thin film of slag. In all of the rolls that were treated with Goldschmidt alloy we also noticed that small crystals of what we call pink slag or titanium nitride were present. This proved to us that the titanium alloy added reacted with the nitrogen occluded in the steel and was thereby changed into titanium nitride, which passed out as slag, on account of its low specific gravity, but leaving very small traces behind entrapped in the steel.

In the carbon-titanium rolls, we failed to observe such pink slag and to our reasoning this was sufficient proof that carbon-titanium had not dissolved at the temperature of that steel and therefore, failed to cause any reaction with the steel other than the reaction of the graphitic carbon contained in the titanium alloy which reacted with the oxides of the slag as soon as the slag touched the ladle, causing the slag to foam on every heat. We also interpreted the drop in temperature which was observed on the carbon-titanium heats as caused by the reaction of the graphitic carbon with the oxides of the slag which formed a large amount of carbon monoxide that had to find its way out of the slag and in doing so it caused the slag to froth up in open channels. Therefore, the radiation losses were greater than in the case where the Goldschmidt alloy was used as in this case the slag blanket did not raise up, but remained quiet on the top of the metal.

The average analyses of the titanium used, follow:

	Goldschmidt carbon-free titanium alloy. Per cent.	Carbon-titanium. Per cent.
Titanium	25.50	12.00
Manganese	0.60	Trace
Carbon	....	6.50
Aluminum	5.75	....
Silicon	0.35	1.50

Phosphorus and sulphur were not determined, but were present in the alloys in very small quantities.

The Chairman.—That is a very interesting discussion. Are there any other users of ferro-titanium present?

Mr. S. F. Comstock.—I would like to suggest that the last speaker might examine some of slag from carbon-titanium treated steel under the microscope, and he would find that it was full of titanium nitride.

Mr. L. Selmi.—I have also examined slag from carbon-free titanium-treated steel under the microscope and noticed considerable pink slag, but the slags from heats treated with ferro-carbon-titanium did not reveal any titanium nitride under the microscope. At the time of this investigation, Mr. Petinot, who was employed by the Titanium Alloy Mfg. Co., called on us and I submitted to him my views as expressed above. I

also gave him three or four specimens of these steels which illustrated the conditions as I have outlined. Mr. Petinot was unable to dispute my contention in this matter and it seemed to me then that he understood the importance of my finding and all he could say was that if I had better success with the free carbon alloy, I should prefer to use the same to the carbon alloy which, of course, I was doing. The amount of titanium nitride that remains in the steel is very small and I don't think it will give any trouble, but in my opinion it is a proof that the titanium has reacted with the steel at a certain temperature.

Mr. E. F. Cone.—I would like to ask which practice is considered the best, to add the titanium in the ladle or in the furnace, in the slab or in large lumps.

The Chairman.—Personally I prefer adding the ferro-titanium in the ladle; I think it is the best practice and I am using it in very small sizes. The ferro-carbon titanium people several years ago did some experimental work by adding the titanium in the furnace in the slab form, but I believe the best practice, both with the carbon-free and the ferro-carbon titanium is adding it in the ladle after the other deoxidizers, ferro-silicon and manganese have been added.

Mr. E. F. Cone.—Do you add the ferro-silicon and manganese in the ladle also?

The Chairman.—Yes.

Mr. E. F. Cone.—What is the percentage of ferro-carbon titanium?

Mr. L. Selmi.—Three and a half pounds per ton in some heats and 10 in others. We started with 10 pounds, but cut it down in some heats, and it varies from 3½ to 10 pounds per ton.

Mr. E. F. Cone.—I just want to say it seems to me that there are two important considerations of this question, which Mr. Janssen has brought out, especially in regard to the substitution of ferro-manganese and I think that the results he gives are really astonishing. Were you using acid or basic steel?

The Chairman.—In our case it was basic steel throughout.

Mr. E. F. Cone.—And you stated that you also insisted on a manganese content in your pig iron? Now it is generally known that manganese is an important deoxidizer. It is being recognized among steel people more and more, and in buying they are insisting on a manganese content of at least 1 per cent or 1½ per cent. I think it would be very interesting if we could get a comparison between the basic and the acid.

The Chairman.—We felt for a long time the great importance of this subject, and we were governed largely by the nature of our products or rather the character of the design of our products; we thought that if we were to produce a steel within the usual sulphur limits we would have trouble, and our entire aim was directed toward reducing our sulphur content as low as possible, working on the possibility that we might get more reduction in the sulphur and an increased amount of manganese in the pig iron together with a very good quality of limestone. We have very careful supervision and I believe the time will come when standard specifications for pig iron will be modified and we will ask for a higher manganese content.

Mr. L. Selmi.—I have not stated in my remarks that I have used titanium in both acid and basic steel; this was at the time that I made the first experiment along this line. The basic steels treated contained carbon ranging from 0.12 to 0.20 per cent. This steel was cast in rectangular plate molds. In some heats of basic steel treated with carbon titanium, when the casting temperature was abnormally high, I observed the crystals of titanium nitride; the abnormally high temperature referred to was 3,300 degrees Fahr. However, these temperatures are by no means absolute, but comparative, that is, the temperatures were taken with the same instrument; when 3,300 degrees was obtained on one heat and 3,000 on the other, one could rely that there was a difference of 300 degrees between the two heats; in cases where the temperatures were abnormally high and the steel was treated with carbon titanium, I obtained the pink slags, which was proof that the desired reaction had taken place. As natural results of high temperature heats,

the ingots showed large pipe; consequently, when rolled into plates, they produced plates that had what is known as *a cold shot at the end,* which had to be discarded. For this reason we aimed to cast our steel at as low a temperature as possible, consistent with foundry practice, in order to get away from this pipe as much as possible. In regard to the results cited by Mr. Janssen, that in using titanium he has succeeded in lowering the amount of manganese in the steel and still gets high tensile results, I might say that I have been unable to duplicate this. I am at present experimenting with the manganese alloy in making steel which runs about 45 to 60 carbon and 60 to 75 manganese. A very strict inspection of this steel is exercised both physically and chemically. So far as I can say that whenever the manganese is below 60 and the carbon is not any higher than what it should be, we cannot get the tensile strength required by the specifications, and so in my experience, titanium does not affect the tensile results in the least.

The Manufacture of Manganese Steel Castings

By W. S. McKee, Chicago

Although the steel foundry industry has made tremendous strides in the past decade, the difficulties surrounding the manufacture of steel castings are scarcely less embarrassing at present than they were ten years ago. As fast as the problems standing in the pathway of progress are solved and removed, new perplexities arise owing to the enlargement of the field of operations.

The growth of the industry has led to specialization and at present there are several large steel foundries in the United States and abroad that concentrate their efforts on the production of high manganese castings. On account of its peculiar properties, including remarkable resistance to abrasive action, manganese steel is used for a great variety of industrial purposes and the shops manufacturing this material in the United States now have a combined capacity of approximately 70,000 tons per year.

Strange to say, however, the difficulties surrounding the manufacture of manganese steel castings do not seem to be as fully appreciated as those connected with the production of ordinary carbon-steel castings, possibly because they have not been as widely discussed. As a matter of fact, the manganese steel founder finds himself confronted with all of the problems of the ordinary steel foundryman, plus a host of special complications arising from the peculiar physical and chemical characteristics of the material with which he is working. In order to achieve success it is necessary to have special experience all along the line, particularly with reference to melting and mixing the metals and heat-treating the castings. It is for the purpose of pointing out and discussing some of the peculiar

problems of the manganese steel foundryman that this paper is presented.

Manganese steel was developed originally in England, largely through the efforts of Sir Robert Hadfield. It has been manufactured on a commercial basis for nearly 26 years. The first manganese steel castings made in the United States were turned out in 1892. Originally it was considered impossible to make manganese castings successfully weighing over a few hundred pounds, but at the present time large rolling mill pinions, crusher heads and similar castings weighing up

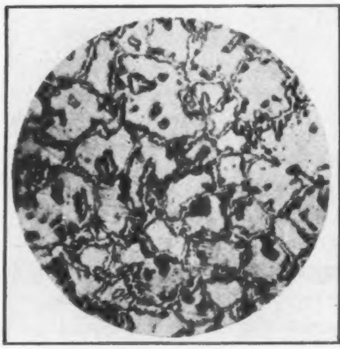

FIG. 1—MICROSTRUCTURE OF CAST MANGANESE STEEL UNTREATED, MAGNIFIED 100 DIAMETERS

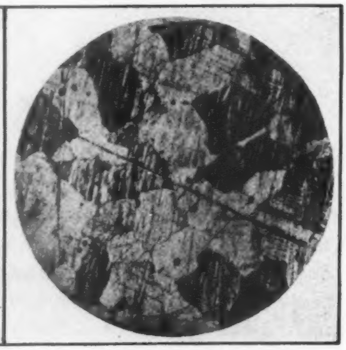

FIG. 2—MICROSTRUCTURE OF CAST MANGANESE STEEL PROPERLY HEATED, MAGNIFIED 100 DIAMETERS

to 30,000 pounds each are being produced regularly and it does not appear that the limit of weight has been reached by a considerable margin.

A Great Variety of Uses

Manganese steel castings are used for a great variety of purposes, including parts for asphalt presses, ball mills, brick and tile machinery, cement kilns, Chilian mills, clay mills, coal breaking machinery, coal mining machinery, concrete mixers, copper converters, traveling cranes, crushers, dredges, gears, grab buckets, steam shovels, lifting magnets, rolling mill machinery, stamp mills, etc. Manganese steel also is employed for the

manufacture of safes, railway frogs and crossings, foundry tumbling barrels, etc.

As manufactured at present, manganese steel is similar in analysis to ordinary converter metal except that it is high in carbon and unusually high in manganese. In ordinary commercial castings the proportions of the latter metal range from 11 to 13½ per cent. This combination of elements gives the finished castings certain distinctive metallographic and physical qualities, which will be detailed later in this paper. From one standpoint, manganese steel is similar to malleable iron in that the casting as it comes from the sand is almost glass hard and very brittle. It must be made ductile by an annealing or heat-treating process. The heat treatment is a very essential part of the process and must be properly manipulated to insure satisfactory results.

The necessity for heat treatment limits the thickness of section which it is possible to cast successfully with manganese steel. Originally the castings were made with comparatively thin sections, but researches carried on during the past few years by prominent manufacturers have resulted in a gradual increase in the thickness of section that it is possible to treat successfully, until at present castings with walls up to 5½ inches in thickness are handled satisfactorily. Heavy castings are cored out to a minimum thickness of 5½ inches. This not only serves to eliminate the internal stresses which invariably are set up in a very thick casting, but also reduces the weight and inertia of the piece, an important consideration if the casting is a moving part in a machine. At the same time, the maximum annealing thickness of 5½ inches is sufficient to permit the use of manganese steel for the heaviest classes of machinery. It is evident from the foregoing, that although manganese steel is made in a converter and cast in sand molds, the process is by no means a simple one. Unusual experience and ability are required if successful results are to be obtained.

Strength of Manganese Steel

The early papers of Sir Robert Hadfield mentioned tensile tests of specimens of manganese steel showing an ultimate strength of approximately 100,000 pounds per square inch with

elongations as high as 40 per cent. In some few instances an ultimate strength of 150,000 pounds per square inch is mentioned by Mr. Hadfield. That the physical characteristics of manganese steel are superior to many high grade steels is indicated by the following figures averaged from a series of 19 tests of manganese steel made by Robert W. Hunt & Co., Chicago. The figures are as follows: Elastic limit, 53,396 pounds per square inch; tensile strength, 108,460 pounds per

FIG. 3—EARLY DESIGN OF DREDGE BUCKET SHOWING SHARP CORNERS IN BACK EYE

square inch; elongation in 2 inches, 33.71 per cent; reduction of area, 38.56 per cent.

Manganese steel does not owe its wear resisting qualities to its hardness. When subjected to the Brinell test, it shows an average hardness number of about 200. The extreme outer fibre of the treated steel shows a slightly lower hardness number than at a depth of about ⅛-inch. From the latter point the hardness remains constant to the core of the casting. The lowering of the hardness at the surface is due to the oxida-

tion of the carbon which forms on the surface during the heat treatment. The toughness of the material is due to its great molecular cohesion which causes the particles to flow rather than to tear off. When tested with a scleroscope, manganese steel shows a hardness of from 40 to 50.

The specific heat ranges from 0.145 at ordinary temperature to about 0.20 at 1200 degrees Cent. Between ordinary atmospheric temperatures and a 600 degree Cent. the heat conductivity

FIG. 4—PRESENT DESIGN OF DREDGE BUCKET WITH CORNERS IN BACK EYE ELIMINATED

appears to be about one-third that of low carbon steel. The specific gravity of manganese steel ingots is nearly the same as the result obtained by the usual method of determining specific gravity with a chemical balance, using a small specimen of cast steel. The rolled steel is slightly heavier than the cast material.

Manganese Steel is Non-Magnetic

The electrical resistance of manganese steel is approximately 3.4 times the resistance of ordinary Bessemer steel. At temperatures between 100 and 600 degrees Cent. the electrical

FIG. 5—GENERAL VIEW OF MOLDING FLOOR OF A TYPICAL MANGANESE STEEL FOUNDRY—NOTE EXTENSIVE CRANE EQUIPMENT

resistance is said to remain practically constant. Manganese steel is non-magnetic and advantage is taken of this property in the use of this material for shields or bottom plates for lifting magnets, such as are extensively employed in foundries.

The shrinkage of manganese steel is excessive, amounting to 5/16-inch per foot as against 3/16-inch to ¼-inch in ordinary steel foundry practice. The high shrinkage creates a number of foundry problems which will be discussed in some detail later.

FIG. 6—MOLDING GUARD RAILS ON A PNEUMATIC JARRING MACHINE

Chemically, cast manganese steel has the following composition:

	Per cent
Carbon	1.25
Silicon	0.30
Manganese	12.50
Sulphur, less than	0.02
Phosphorus, about	0.08

The distinctive characteristics of manganese steel are clearly delineated by the microscope. It is well known that manganese

FIG. 7—HEAT-TREATING FURNACES WITH TANKS FOR QUENCHING CASTINGS

is present in all ordinary steel, but the metal does not become austenitic until about 6 per cent manganese and 0.80 per cent carbon are introduced. Commercial manganese steel generally contains from 11 to 13½ per cent manganese and from 1.00 to 1.30 per cent carbon.

Proper Structure Can Be Determined

In the cast state the metal is composed principally of austenite and free cementite, austenite being a solution of iron, manganese and carbide of iron and manganese, while free cementite is composed of the carbide of iron and manganese which remain undissolved. Free cementite is very hard and brittle and therefore manganese steel is also very brittle in the cast condition. However, upon receiving a proper heat treatment all of the free cementite is dissolved forming austenite which is known to be very ductile and to present a high resistance to wear. We thus have a metallographic explanation of the chief characteristics of manganese steel. In order to obtain the austenitic structure it is necessary that the steel be given a correct treatment. Microscopic examination reveals the fact that if the steel is heated to a proper temperature and quenched in water, it is composed entirely of austenite. By the aid of the microscope, therefore, the proper structure can be determined and together with physical tests and chemical analysis most excellent results are obtained.

The accompanying microphotographs, Fig. 1 and Fig. 2, show the structures of manganese steel as cast and after treatment, magnified 100 diameters. Fig. 1 shows the structure of manganese steel in the cast condition. Fig. 2 shows the same steel heated to a temperature of 1800 degrees Fahr. and quenched in water. It will be noted that since the heat treatment is correct, all of the free cementite has disappeared leaving a purely austenitic structure. If the steel is again heated to over 700 degrees Fahr. the pure austenitic structure is destroyed, seriously injuring the quality of the metal. It, therefore, is imperative that manganese steel should not be heated to a temperature exceeding 700 degrees Fahr. after leaving the foundry where it was manufactured.

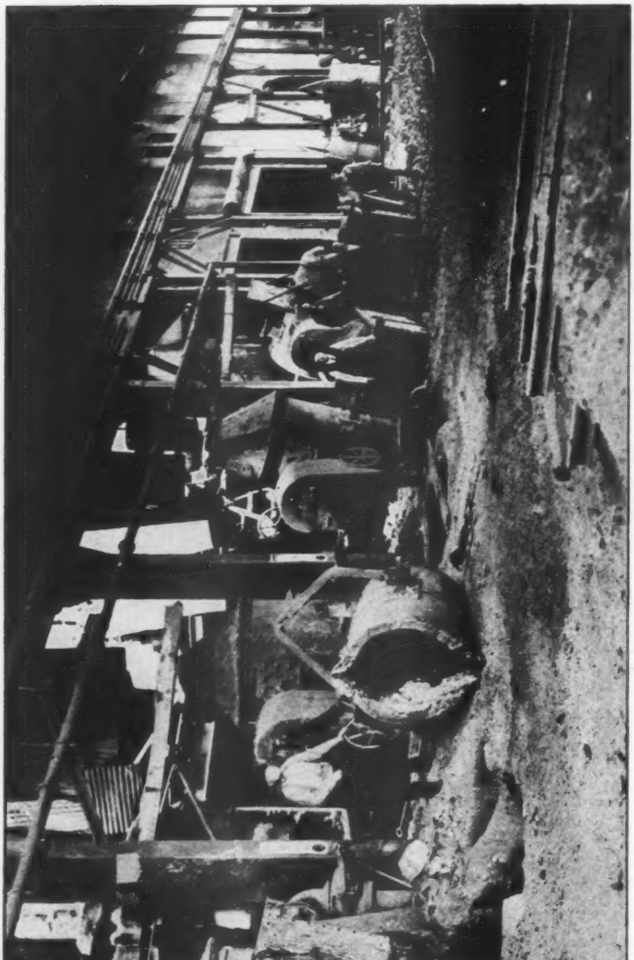

FIG. 8—CONVERTER EQUIPMENT IN A MANGANESE STEEL FOUNDRY

Owing to shrinkage difficulties and to the problems connected with annealing, it is necessary, in order to achieve success in the manufacture of manganese steel castings, to start with the design of the parts. A few simple changes in design may spell the difference between success and failure in the foundry. It is necessary for the designer, however, to have a thorough

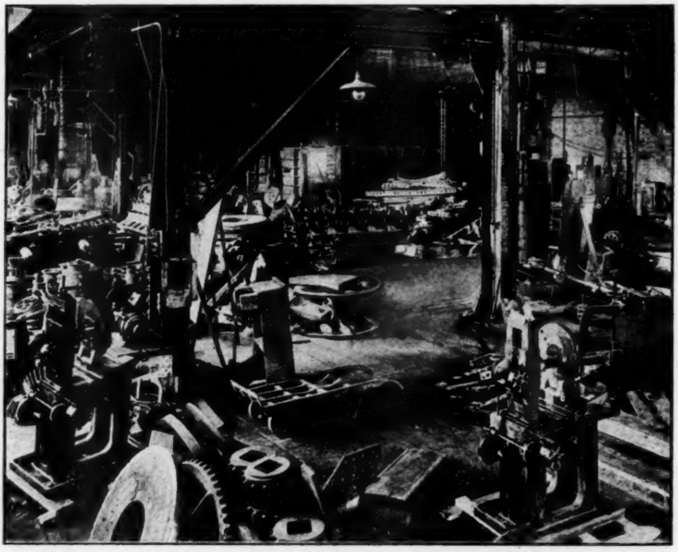

FIG. 9—GRINDING ROOM IN A LARGE MANGANESE STEEL FOUNDRY

knowledge of the peculiarities of the metal. The importance of correct design is very clearly indicated by the dredge buckets shown in Figs. 3 and 4. The original type of bucket is shown in Fig. 3 and the improved design in Fig. 4. In Fig. 3 it will be noted that there are two square corners in the back eye. In this design the bushing, with which the eye is fitted, bears on the shoulders created by the two sharp corners previously mentioned. Although these corners were provided with a

small fillet it was found extremely difficult to insure perfectly sound metal at this point. As a result, the bucket was apt to fail at one of the points of greatest stress.

Effect of Improved Design

In the improved design shown in Fig. 4 it will be noted that the two square corners have been entirely eliminated resulting in a much more satisfactory job from a foundryman's

FIG. 10—GRINDING TRACK CASTINGS IN A MANGANESE STEEL FOUNDRY

standpoint. Fig. 4 not only shows the new form of the back eye but also illustrates the bushing with which the eye is fitted. Generally speaking it is more necessary to avoid an abrupt change in section and sharp corners when making manganese steel than when turning out ordinary low carbon steel castings.

It is necessary that the pattern be provided with the proper shrinkage allowances and for this reason many manganese steel

foundrymen prefer to make their own patterns from original drawings supplied by their customers. When patterns are furnished they frequently have to be rebuilt in order to obtain satisfactory results. The allowances for shrinkage are not confined simply to the dimensions of the pattern, but also include the distribution of the metal in the casting.

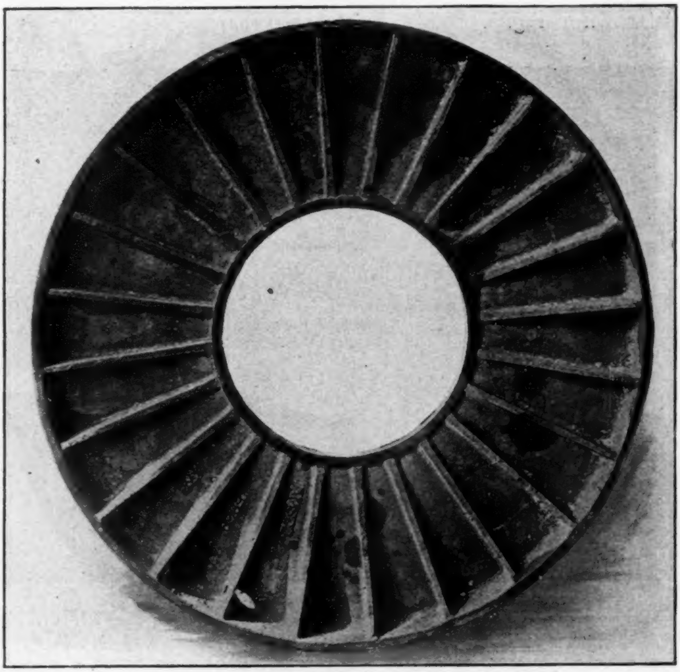

FIG. 11—COIL SHIELD FOR LIFTING MAGNET

At times it is necessary to add metal to a casting temporarily to withstand shrinkage strains; such additions of metal are removed in the machine shop by grinding before the casting is shipped. In handling work of this character, unusual skill is necessary in order to properly allow for shrinkage stresses.

While a majority of the patterns used in manganese steel foundries are made of wood, it has been found advantageous

to use metal where great durability is required, as in ordinary practice. A complete manganese steel casting plant, therefore, should include a properly equipped pattern shop provided with band saws, circular saws, woodworking lathes, and boring and mortising machines, together with other equipment for the rapid and economical production of patterns.

The molding floor of a typical large manganese steel foundry is shown in Fig. 5. It will be observed that the crane equipment

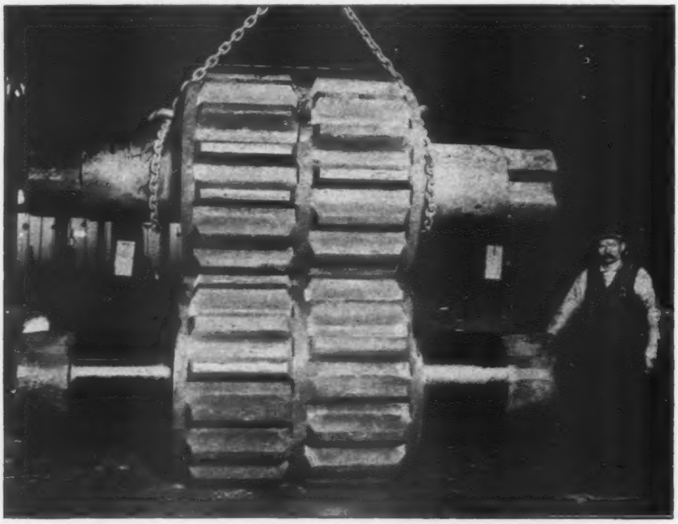

FIG. 12—HEAVY 52-INCH MANGANESE STEEL ROLLING MILL PINIONS

is extensive including heavy electric traveling cranes which span the entire floor, supplemented by wall cranes. In making molds it has been found that ordinary molding sand and clay binders are unsatisfactory on account of the cutting action of the molten metal. Sands with a high percentage of silica are used and most of the molds are oven dried. Special facing mixtures are required owing to the crushing effect of the shrinking manganese steel. An open facing which will yield readily is necessary, but at the same time sufficient skin hardness to

prevent the mold from being washed away is required. Similar difficulties are encountered in providing proper core sand mixtures. These mixtures must be free venting; they must have sufficient strength to stand up properly under the destructive action of the molten metal and at the same time the core must yield readily when the casting commences to shrink. The larger manufacturers of manganese steel have conducted

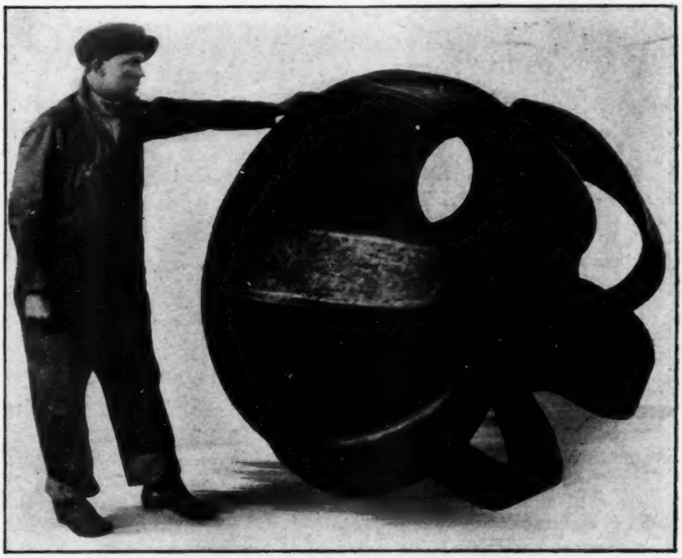

FIG. 13—LARGE MANGANESE STEEL CUTTER HEAD

extensive experiments which have enabled them to determine the proper mixtures for facings and core sand and to develop standard formulas.

Molding Machines are Used Extensively

For the economical production of heavy molds, jar ramming machines are used to advantage as in ordinary steel foundries. At the plant of the American Manganese Steel Co., Chicago Heights, Ill., for instance, guard rails are made on a pneu-

matic jarring machine. This machine, which is illustrated in Fig. 6, is provided with a table 3 feet 4 inches wide and 10 feet 4 inches long. The molds are made in cast iron flasks, 9 feet 9 inches long and 2 feet wide, both the copes and the drags being rammed on the machine. The patterns are mounted

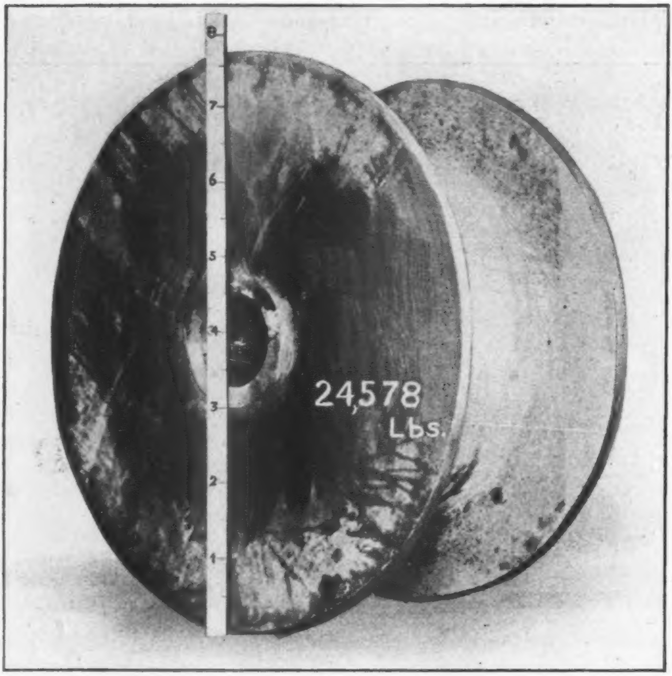

FIG. 14—MANGANESE STEEL DREDGE TUMBLER WEIGHING 24,578 POUNDS

on a follow board. The copes are barred, gaggered and rammed right side up with the pattern underneath, a green sand core extending from the cope into the drag portion of the mold. Fig. 6 shows a drag on the machine just after it has been rammed and struck off. Before being rolled-over it is provided with a heavy cast iron bottom board. The guard rail castings

made in this plant are each about 8 feet long and six men turn out about 30 molds a day. The molds are poured two-up with a large and a small ladle. Each mold is provided with a 1½-inch riser in the middle. Other methods are employed in molding other castings. The rolling mill pinions, Fig. 12, for instance, are molded vertically in a four part flask provided with goose neck gates. In this case the metal enters from the bottom. Large shrink heads are necessary and it also is essential that the molds be arranged so that the casting may be fed properly during the cooling period.

How the Metal is Melted

For melting the metal standard side blow converters, such as those illustrated in Fig. 8, have been found satisfactory. At the Chicago Heights plant of the American Manganese Steel Co. two cupolas are provided for the primary melting of the metal and four three-ton converters are installed. The cupolas are situated on a mezzanine floor behind the converters and are so arranged that the metal may be drained directly from the cupola spouts into the converters. The ladle and crane equipment is similar to that found in the average steel foundry handling heavy work.

Manganese steel is a special converter metal to which a quantity of ferro-manganese is added in the ladle. Standard 80 per cent ferro-manganese is employed and it is necessary to provide suitable facilities for melting this material. For this purpose either crucibles or specially designed reverberatory furnaces may be employed. If the latter method is used, considerable experience is required to design the furnace properly and to operate it successfully. The reverberatory furnace, however, has certain advantages over the crucible method, inasmuch as under proper conditions the labor cost is much less. The working conditions in the furnace room also are less severe and the cost of crucibles, no small item at the present time, is eliminated.

The melted alloy is placed in the bottom of the ladle and the steel from the converter is poured in on top, enough ferro-manganese being used so that the castings will show about 12½

per cent manganese when analyzed. This is an average figure; the exact quantity of manganese varies somewhat with the nature of the work. The manganese acts as a strong scavenger, removing the gases and impurities from the metal, leaving it condensed and homogeneous. The production of slag is excessive and before the molds are poured the ladles are allowed to stand for a time in order to permit the alloy to perform its function and also to skim off the slag. The raw materials used in the production of the converter metal include low-phosphorus pig iron and selected steel scrap, similar to those used in the ordinary bessemer steel foundry. The same careful selection is necessary to insure uniformity in the finished product. The metal is handled and poured while very hot.

As previously mentioned, when the castings come from the sand they are glass hard and before they are suitable for use they must be annealed. For this purpose furnaces of the proper size in which the temperature may be readily controlled are necessary, together with quenching tanks and suitable crane equipment for handling the hot castings. The annealing furnaces are of the ordinary open-flue type. Usually they are provided with cars on which the castings are placed for the heat-treating process. It is essential that as little time as possible elapse between the moment when the furnace door is opened and that when the casting is immersed in the quenching tank. It is, therefore, desirable to locate the tanks directly in front of the annealing furnaces as shown in Fig. 7.

Some Details of Heat Treatment

In discussing the heat treatment of manganese steel, W. S. Potter in a paper presented before the Western Society of Engineers, at Chicago, on Feb. 17, 1909, makes the following interesting statements:

"Upward of 75 years ago men in Sheffield, Eng., understood that steel containing moderate additions of manganese had certain properties which could be described as those of carbon steel, and that steels containing a higher percentage than 5 per cent or 5½ per cent were very weak and brittle.

"Some 30 years ago the Hadfields, father and son, or their associates, found, and the son advertised, the fact that castings and forgings containing the higher percentages of manganese, after heating to a high temperature and quenching in water, were very strong and tough and that the treated steel had remarkable resistance to abrasive wear. The proportion of manganese mentioned as suitable for track-work castings, in Hadfield's early patents is 11 per cent. No heat treatment was mentioned in the early papers, but later a treatment was announced and consisted in heating the casting at first slowly and then rapidly to 800 degrees, 900 degrees, or 1,000 degrees Cent., and immediately quenching in water. No theory covering the necessity of this reheating and quenching was given.

"Manganese steel of ordinary composition poured in a layer about ¼-inch to ½-inch thick in a chill mold will, when cold, bend double, and has all the usual toughness of reheated and quenched manganese steel. Castings from the same ladle of steel poured in sand molds have a toughness approximating the toughness of the reheated and quenched metal in inverse proportion to the thickness of the sand cast section. For example, a sand-cast section ½-inch thick will usually bend from 45 degrees to 90 degrees before it breaks by cold bending. A section 2 inches thick usually breaks in cold bending before it is deflected as much as 20 degrees. The thinner section is whiter and has smaller crystals than the heavy sand-cast section, and the chill-cast section is still whiter and has still smaller crystals than the thin sand-cast section. If the three specimens are heated to 1,000 degrees Cent. and quenched in water they will exhibit in each case a very remarkable and practically equal degree of toughness. In all these cases the steel has practically the same hardness. The chill-cast specimen, before reheating, is the hardest; the sand-cast specimens are the softest. If the specimens are now heated to 700 degrees Cent., or even a little lower temperature, held for, say one-half hour at this temperature, and cooled slowly to ordinary temperature and broken, they are surprisingly weak, and as a rule, bend but slightly before breaking. The crystals are very large and it is obvious that no strong cementing materials

are present to bond the crystals. A section 3 inches thick cooled slowly from the heat of casting, and put under a drop weight will break about as readily as an equal thickness of a fair quality of gray iron and will frequently show crystals with a mirror surface as large as 1¼ x 1 inch. For the most part such a section so treated and broken will show crystals about ¼-inch to ⅜-inch on a side. A specimen heated to above 700 degrees Cent. and cooled slowly to below 600 degrees Cent., is very weak. If this specimen is reheated to 700 degrees Cent., and quenched in water only, a slight increase in toughness is noted. The crystals are still apparently as large as ever. The bond between the crystals is almost as weak as before, and yet from the other tests it is clear that the steel crystalizes or re-crystalizes considerably below 700 degrees Cent.

Not Readily Taken Into Solution

"Comparing this steel with a carbon steel it is obvious that the cementing materials are not taken into solution at as low a heat in the manganese steel as in the carbon steel. In the carbon steel, the size of crystals, strength, toughness, etc., may be redetermined any number of times by reheating to 700 degrees Cent. and cooling, and as is well known, the physical properties are governed by the rate of cooling.

"The manganese steel after being put in a weak condition due to slow cooling from 700 degrees or above is only put in a condition of maximum toughness by reheating to a much higher temperature and then cooling rapidly enough to prevent either mechanical or chemical separation.

"A comparison of color carbon tests with determinations of total carbon by combustion, shows that the slow cooled steel has a much smaller amount of carbon in the condition which permits of the determination of carbon by color than the manganese steel which has been rapidly cooled. The highest color result is obtained from the thin chill-cast section, the next highest from a specimen heated for a short time only and quenched in water. The lowest carbon result (by color test) is found in the specimen which has been heated to a high

temperature, maintained at this temperature for some time and cooled very slowly. The chill-cast specimen showing by total carbon determination 110 points carbon, by color test may show 105 to 108 points. The specimen annealed at a high heat will give color results ranging from 0.60 to 0.95 per cent, depending upon the time to which the specimen was exposed to the highest temperature, the rate of cooling, and the percentages of manganese and silicon.

Silicon Plays an Important Part

"As might be anticipated from the general knowledge pertaining to the art of "black heart" malleable iron manufacture, the percentage of silicon plays a very important part in the decomposition of carbides of iron and manganese in manganese steel.

"Manganese steel is readily burned when heated, and this burning is more difficult to avoid as the temperature is higher. For this reason it is usual to heat for quenching only to a point sufficiently high to give the characteristic toughness in the quenched metal.

"If castings or other finished shapes are reheated for toughening to a high temperature they are apt to be very generally affected with deep cracks. To avoid burning and cracking the reheating is generally stopped at about 1000 degrees Cent."

In operating the annealing ovens or furnaces it is necessary to heat the castings up slowly so as not to create expansion strains which will cause cracks. If the castings are heated rapidly the outside, of course, heats faster than the core, resulting in internal stresses of a serious nature. After the proper annealing temperature is reached, from 1600 to 2200 degrees Fahr., the castings must be given a soaking heat for several hours in order to bring the molecules into a state of equilibrium. The time required for this operation varies from four to 24 hours depending on the size and character of the casting. As previously stated, the thickness of the metal which can be successfully annealed has gradually been increased until now castings with walls 5½ inches thick are handled without any great

difficulty. It is advisable to have the water in the quenching tanks as cold as possible in order to cool the castings quickly, before there is any time for internal structural changes. The men drawing the castings from the annealing furnaces must be protected from the heat with special clothing and helmets. Respirators also are desirable owing to the noxious gases emitted from the furnace when the door is opened.

Not Easily Cleaned

The proper cleaning of manganese steel castings presents many problems in itself. Very little sand adheres after the casting comes from the quenching bath. The metal is so tough, however, that practically all of the trimming operations must be conducted by grinding. Extensive portable, electrically-driven grinding equipment is necessary for this purpose. The method of grinding track work is shown clearly in Fig. 10. A general view of a modern manganese steel foundry grinding and cleaning room is shown in Fig. 9. It will be noticed that a heavy investment is required in order to properly equip this portion of the plant.

Most manufacturers of manganese steel castings have found it advisable to establish extensive machine shops in connection with their plants. If the castings are to be finished in any way, special equipment is necessary. Ordinary machining methods are unsuccessful and grinding must be resorted to. Holes, more than ¼-inch in diameter, are cored in the castings. When required, cored holes 1½-inches or larger may be finish ground to size with special wheels. When it is necessary to drill smaller holes or to cut threads soft steel or wrought iron inserts are set in the molds at the desired points like chaplets and the metal is cast around them. Incidentally this adds to the difficulties of the foundryman. Sometimes bushings are set in the hubs of gear wheels when it is desired to machine them by ordinary methods. Liberal allowances of metal are made for grinding in order to minimize the danger of spoiling the work in the machine shop.

It is necessary for the machine shop foreman to exercise his judgment continually; coarse wheels and heavy cuts are

used so that the metal is removed rapidly, although by no means as easily as would be the case were it possible to employ ordinary cutting tools.

Some of the Uses for Manganese Steel

Some mention already has been made of the purposes for which manganese steel is used. In the foundry, manganese steel is used for the linings for tumbling mills as well as for gears, crane wheels, elevator buckets, grab buckets, lifting magnet shields, etc. This material is particularly desirable for lining tumbling mills owing to its extreme resistance to abrasion.

Where loads are heavy, manganese steel is extensively employed for gears and for the past three or four years it has been possible to produce manganese steel spur gears with the teeth ground theoretically correct. Ground gears now can be provided up to 44 inches pitch diameter with a 10-inch width of face. Many ordinary steel gears are cut with a range cutter which does not leave the rolling contact theoretically correct, whereas in grinding manganese steel gears a trimming arrangement is placed on the grinder for the purpose of dressing the emery wheel to the proper contour of the tooth face, so that when the mating gears are meshed each tooth is provided with a perfect contour on which to roll.

After two years continuous service, the wear on a set of heavy, high-speed manganese nest gears recently was measured. These gears had a 10-inch face and when new, the tooth measurement at the pitch line was 0.684-inch. At the conclusion of the two years' service, the tooth measured 0.601-inch . These gears are still in service after having more than earned their original cost and barring accidents they should be good for many years to come. The total wear was less than 0.10-inch.

Manganese steel has advantages for crane wheels where uniform diameters must be maintained on the drives to insure straight alignment in travel. A microscopic examination of a manganese steel wheel under load will show a flat spot instead of a line contact as in the case of hard metal wheels. Manganese steel under these conditions is springy and recoils as the load

is released. About 30,000 pounds always has been considered a safe working load on chilled iron wheels for this purpose. Manganese steel crane wheels, however, are in successful use with rolling loads of 90,000 pounds per wheel.

Manganese steel also is extensively employed in the manufacture of rolling mill machinery. It has been found particularly suitable for the pinions on heavy roughing and blooming mills. A set of typical rolling mill pinions made of cast manganese steel are shown in Fig. 12. These pinions are cored out to a maximum thickness of 5½ inches, which decreases their inertia. Many other machine parts around steel mills are now being made of manganese steel including pipe drawing balls, chafing plates, sprockets, cams, draw chains, unloader chains, conveyor chains and buckets, screens, crusher castings, etc.

It will be appreciated from the foregoing that the successful production of manganese steel castings involves a wide experience in machine design and construction as well as in foundry practice and metallurgy.

Acid vs. Basic Steel for Castings

By Edwin F. Cone, New York

Consideration of this subject is practically confined to open-hearth steel. And it is not so much a question of the acid as a competitor of the basic as it is one of comparison. About 85 per cent of the steel going into steel castings in this country is made in the open-hearth furnace. In 1915 the open-hearth output was 84.9 per cent of the total; in 1914 it was 87.1 per cent. Castings from the converter and the crucible are regarded as acid steel while those made from the electric furnace are either acid or basic. But in the latter cases melting conditions are so different from those ruling in the open-hearth furnace that the steel can hardly be considered when discussing the open-hearth product.

Uses of Acid and Basic Castings

There has been recognized for a long time a distinct dividing line between acid and basic steel castings. Castings which, before being put to their final use, are necessarily machined all over, or to a large extent, are almost universally specified and made of acid open-hearth steel. All other castings, principally bolsters, draw-bars, knuckles, etc., are poured from basic steel. This is the recognized practice.

The principal reason for this is not that one is inherently stronger than the other, but because acid steel, when properly made, is usually sounder and freer from defects. Hence it is less liable to reveal defects when machined and is therefore less subject to rejection.

It is unnecessary to deal minutely with the reasons for this before such a representative assemblage of foundrymen and steel foundrymen in particular. Briefly, this condition in basic steel is due to its inherent wildness after it has left the furnace. There is in fact only one distinct handicap which prevents basic steel from possessing a decided advantage over acid steel for casting purposes. When the basic

steel has left the furnace and is covered with its slag in the ladle, a reaction at once starts between the steel and the slag consisting of a combination between the calcium of the slag and the silicon of the steel, by which silicon leaves the metal and goes into the slag and phosphorus leaves the slag and goes into the metal. The result is that the latter part of the heat is high in phosphorus and low in silicon—often low enough to cause the metal to be porous when cast.

Naturally steel in which such a reaction is constantly going on cannot be as dense and solid as that made in the absence of such conditions. In acid steel of course, the conditions are largely the opposite. It is purely a melting and not a refining process, and if carefully carried out the steel is inevitably sounder. This is the main reason why it is specified for machined and jobbing castings in general.

In the steel foundry department of one of the largest steel plants in this country I was astonished to see a few years ago a 25-ton basic heat being poured for 45 minutes into small molds. It is hardly necessary to recount that towards the end of the heat the crop of "cauliflower" sink heads was a large one. It was then the custom in that plant to order from the open-hearth department a 0.25 per cent carbon heat for castings and the molding floor was sent any heat ready at the specified time, whether acid or basic. The losses were always large.

To overcome a low silicon content in the last stages of a basic heat it is customary often to start with a high initial silicon, perhaps 0.40 to 0.45 per cent, especially where considerable time must elapse in pouring the heat. But even then, a basic slag being more highly oxidized than an acid slag, the metal at the end of the operation is more highly charged with oxygen, tending to less sound steel. The average basic heat will analyze lower in silicon at the end than at the beginning of the pour, often by 50 per cent.

Attempts to Overcome Slag Contamination

Attempts to avoid this slag contamination of basic steel in the ladle have been many. Some have tried to remove the slag from the ladle and substitute an acid slag but with-

out gratifying success, so far as I know. Only one really effectual means of avoiding slag contamination has been accomplished. This consists in tapping a heat through one ladle into another, leaving the slag in the first ladle. By tapping the metal from the furnace into a ladle containing a nozzle and stopper about 6 inches in diameter, and then bottom-pouring the metal into a second ladle, all the slag can be retained in the first ladle. Such a method is claimed to be entirely effectual in overcoming the slag contamination, but to carry it out the steel must of course be run excessively hot in order to undergo this transfer and still be suitable to avoid misruns. In addition the metal is not benefited but rather injured by being made excessively hot. The furnaces also are injured more quickly and the fuel cost is higher, so that the cost of the furnace repairs and the additional ladle make the practice virtually prohibitive.

The Addition of Ferro-Alloys

It can hardly be gainsaid that the best steel is made entirely in the furnace and not in the ladle. This is recognized by most metallurgists. The acid process has a distinct advantage in that additions of ferro-manganese and ferro-silicon can be made without difficulty directly to the metal in the bath, whereas in the basic practice this is not the case. Though many acid foundries add the manganese to the metal as it flows into the ladle, careful investigations show that the steel is better if these additions are made to the furnace, even though the consumption of manganese is greater.

Because of the reactions between the basic slag and the metal in basic practice, these recarburizers must be added largely to the ladle. Some large producers of basic steel castings add a part of their silicon to the bath in the form of 11 per cent silicon pig and then obtain the desired silicon content in the steel by adding the 50 per cent alloy to the ladle. The ferromanganese is added either to the bath after the high silicon pig or to the ladle after the 50 per cent alloy, or a part is added both ways, depending on conditions. The last is the

more common practice. In any case, the functions of the silicon and the manganese as purifiers, scavengers and strengtheners of the steel are more thoroughly and efficiently performed by the intimate mixing and contact secured by finishing the steel in the furnace. You can't make as good a loaf of bread by introducing part of the ingredients after the kneading.

The Question of Oxygen

The question of oxygen is an important one in comparing these two grades of steel. To what extent oxygen in steel is harmful is not definitely decided. An authority stated recently that the results of extensive investigations warrant the conclusion that oxygen in steel, if it exceeds 0.01 per cent, tends to produce brittleness under shock. He gives the oxygen content of acid and basic open-hearth steels, as deduced from a large number of analyses as follows:

	Per Cent
Acid open-hearth steel	0.010
Basic open-hearth steel	0.019

The difference here cited is not a large one and it is just as easy to make a high oxygen acid heat as a poor basic heat if the furnace practice is not carefully watched.

Basic open-hearth steel, however, other things being equal, is of necessity the more highly oxidized one. The reactions and conditions involved cause this. In commercial steel castings this question is not likely an important one, as many basic castings are used successfully under conditions necessitating the withstanding of severe shocks. It is, however, a fact that more manganese is necessary as a neutralizer of this more highly oxidized condition than is the case in acid steel. The manganese consumption is therefore higher, as is also the silicon for reasons previously stated.

But in electric steel castings, even from a basic bottom, the manganese consumption is decidedly lower than with the acid or basic open-hearth. This shows the healthy condition of the steel, especially as to its oxygen content. From

one-third to one-half as much manganese is necessary in electric practice as in the open-hearth to achieve the same results.

In normal times basic steel is considered less expensive to make because of cheaper pig iron and scrap. But these are more or less offset by the greater cost of the furnace lining and lime additions necessary. The result of the refining action of the basic furnace is a steel purer in respect to phosphorus and sulphur than is the acid steel. It is doubtful whether this alone is a particular advantage. The harmful effect of phosphorus and of sulphur in particular within limits has been exaggerated and it is not likely that this difference alone confers any special merit on basic steel. Electric steel can be made so low in these two elements as to be considered by some a disadvantage.

Because selected materials must be used in making acid steel, many engineers have thought that a better grade of steel results. This is not a full statement of the case. It is the inherent conditions of the two processes that rule. Electric steel from the poorest scrap on a basic bottom can be made that is equal or superior to the finest crucible steel made from the most expensive selected stock.

Comparative Physical Properties

As to comparative physical properties, one of the largest makers of both acid and basic steel castings in the country gives it as his opinion that basic steel shows higher ductility for a given tensile strength than acid steel and as good an elastic ratio. I am unable to verify this statement from investigation. I have, however, seen some remarkable results from basic steel castings, superior to those from acid steel.

So many factors enter into this question that a very thorough investigation would be necessary to decide it, in my opinion. If basic is better, it is doubtless due to the fact that the refining conditions are an important factor. In the acid process old scrap is constantly remelted; the

only virgin metal is the pig iron. In the basic, old scrap is refined in remelting and the proportion of pig iron or virgin metal is twice as great. These may be important factors.

Basic Castings From Acid Scrap

A very interesting modification of the usual basic process for producing steel castings is being practiced successfully by a large foundry in this country. The results obtained are interesting and striking. Acid quality scrap is used on a basic bottom. The only difference between the procedure at this foundry and at regular acid foundries is that they buy the same scrap that the acid producers use and a grade of pig iron similar in every way except its silicon content. The operation in other respects is the same as regular basic practice. Less lime by 50 per cent is used or necessary. The additions are made as in usual basic practice. The time for refining and hence for completion of a heat is less, as well as the wear on the furnace.

While the probable expense of this practice per ton of metal in the ladle may perhaps be more than for acid metal, though the opposite is claimed by the interested parties, it is asserted that the metal is better than either acid or regular basic and that the percentage of rejected castings is less by a considerable margin.

In favor of this argument is the fact that the absence of considerable refining, with consequently less chemical action, tends to produce a less oxidized metal resulting in one low in phosphorus or sulphur or containing less inherent wildness. Castings made by this procedure are continually competing with the same castings from acid foundries; they are reported as unusually sound and free from cracks and other defects. Locomotive frames, ship castings and machinery parts have been on the market from this foundry for five or six years now and are reported by users or inspectors as of the highest grade. It is claimed that the theory that basic steel is not suitable for the castings com-

monly made in acid has been exploded. It is at least a fact that here is a case where miscellaneous jobbing castings of all sizes, from very small to large ones, are made in basic steel and with excellent commercial results.

German and American Steel Castings

It is interesting to compare the relative open-hearth steel casting output of this country and the casting output of Germany. The following table gives parallel figures of the percentage of acid steel castings in the total steel foundry output of the two countries for the last 15 years:

	UNITED STATES		GERMANY	
Years	Acid open-hearth castings, per cent of total	Total open-hearth castings, gross tons	Acid castings, per cent of total	Total castings, metric tons
1901	68.4	301,622	37.0	107,210
1902	69.6	367,879	40.0	116,524
1903	66.3	400,348	34.3	131,756
1904	67.5	302,834	30.3	152,814
1905	60.9	526,540	35.1	186,131
1906	56.5	719,891	41.0	189,313
1907	50.9	746,525	40.4	211,498
1908	50.4	311,777	40.1	192,883
1909	49.0	601,040	40.3	206,456
1910	49.7	863,351	42.5	262,811
1911	53.3	571,191	37.9	269,372
1912	49.0	870,848	31.1	321,663
1913	49.4	910,216	30.1	362,916
1914	44.7	604,317	29.1	298,338
1915	54.7	735,332	27.8	694,515

In this country there has been a gradually decreasing proportion of acid castings since 1901, with the exception of the years 1911 and 1915. In Germany the basic predominates and is surprisingly larger than in the United States. This is especially true in the last two years under war conditions, though as a general rule Germany's use of basic castings is more extensive than ours. Since 1906 the falling off in the proportion of acid castings there has been quite pronounced.

Speculation as to the cause of this difference in conditions in the two countries is not likely to be profitable. We have often heard it said that German efficiency has produced

better castings than American practice, be it acid or basic steel. It is probable that the general use to which they are put is not greatly different in the two countries. If this is so, the Germans must possess some method by which their basic castings are more acceptable than ours or else American foundrymen have too little faith in the metal they make. Is the desire in this country for tonnage rather than quality the answer? Or do the Germans produce a large proportion of their castings from acid scrap on a basic bottom?

The Gain in Basic

The gain of the basic on the acid castings has been pronounced in both countries. There is no reason why the basic should not continue to gain. With rapid advances in metallurgical practice it is not unlikely that a way will be found whereby basic may become equally interchangeable with acid for steel castings. To what extent electric steel castings may affect this question is important. As bearing on this, it is interesting to note that of the total steel casting output of the United Sates in 1909, only 0.05 per cent was electric steel. In 1915, electric steel castings comprised 2.6 per cent of the total and the output has only begun to grow.

Discussion

THE CHAIRMAN, W. A. JANSSEN.—This subject has always been one of very great interest; it has been one we have tried to dispose of for several years. We assigned it first to an acid open hearth man and he said there was no room for discussion, that he could answer the question right off, "that acid was best." We had a similar reply from a basic man, so we had to get a neutral man to write the paper.

MR. JOHN MCKEOWN.—I would like to ask if there is any way that the basic furnace can make good machinery castings, if it ever has been done commercially?

Mr. R. A. Bull.—The author who has compared acid and basic steel for castings, has evidently made as careful an analysis as the data at his command has permitted. It is not a desire to criticize his study of this important question that prompts a basic steel founder to comment on the paper. In my opinion, no exposition of this subject could be prepared at this time, which would fail to produce dissenting discussion. Hence the appropriateness of the topic.

The significant dividing line between acid and basic castings is not that which falls between foundries making castings to be machined and those which do not, but is a geographical one separating the east from the middle west. The manufacture of steel castings in this country naturally began in the eastern states, and at a period when deoxidizers were employed with indifferent success. About the time when steel foundries began to flourish in territory contiguous to the Mississippi, the manufacture and use of satisfactory deoxidizers experienced important development. The example of the western pioneers in the steel-casting industry in experimenting with the treatment of metal made on a basic bottom, was followed by many progressive founders in the middle west. The east has been slow to discontinue its acid practice. Most of its foundry melters do not favor a change to conditions with which they are inexperienced. Meanwhile, in the central and western states, the success attending basic practice for general steel foundry work has justified those who pinned their faith to it.

The west has taken the lead in developing several phases of steel foundry practice, notably molding in green sand. Not longer ago than nine years since a prominent eastern technical journal published over the signature of one of its staff, a statement that substantially affirmed the impossibility of making steel castings in green sand. At that time, probably 20 per cent of the tonnage of steel castings made in this country was molded in green sand in central and western states where the foundries were not so significant in number as in the magnitude of operations. The eastern writer was not informed of what was being done in districts not under his personal notice. It would

seem that the author of the paper just presented labors under a similar handicap.

It would needlessly take much time to here present the reasons for the satisfactory use of a basic bottom for steel foundry work, other than to ascribe briefly the credit to the intelligent use of well-adapted deoxidizers and skillful manipulation of furnace and heats. Mr. Cone has expressed astonishment at seeing a 25-ton basic heat poured for 45 minutes into small molds, a few years ago. He says the expected result was a large crop of cauliflower sinkheads, toward the end of the heat. Anyone who visits foundries in the west and middle west can daily observe heats of from 12 to 30 tons being poured in periods ranging from 30 minutes to an hour with all risers appreciably cupped, not excepting the sink-heads on the last molds poured. The reduction in the silicon content, which Mr. Cone claims often amounts to 50 per cent, is not really a serious matter. It would be if 50 per cent were an average decrease, and if an appreciable quantity of steel were thus affected.

It is better to quote from actual records than to make general statements. The percentage of metal affected by reduced silicon-content is an important factor to which Mr. Cone refers only by the indefinite phrase "the last part of the heat". And to absolve basic founders from prejudice, we will here admit to a reduction not only in silicon-content, but in manganese-content, to which latter fault Mr. Cone makes no reference.

Analyses of hundreds of 58,000-pound basic heats requiring an average time of 50 minutes to pour, in a steel foundry whose practice is not claimed as superior to that of other well-regulated shops, show no appreciable change in composition occurs under anything like normal conditions except in the last 1,000 pounds teemed. The observant foundryman has convenient means at hand for partially controlling and wholly ascertaining this change. Control is gained by maintaining to reasonable depth the slag covering the metal in the ladle. Experience shows that an excessive amount of slag has greater influence on the chemical composition of the underlying metal than does a moderate coating required for heat conservation. Determina-

tion of the extent of change is, of course, by holding for chemical analysis the castings poured in the last part of the heat.

The extent to which changes occur under average conditions may be intelligently gaged by quoting average silicon and manganese determinations of a month's run in a large basic foundry which melted approximately 6,600 tons of metal last month. The average percentage of silicon in the metal poured in the middle of each heat was 0.36, while the percentage of the same element in the last metal out of the nozzle was 0.264 Corresponding tests for manganese showed, respectively, 0.77 per cent and 0.68 per ecnt. The maximum loss in silicon-content averaged 26 per cent, while that for manganese-content averaged 11.7 per cent. I submit the question if such losses are serious when confined to 2 per cent of the metal lying just beneath the slag, particularly when the pouring of flask and other shop equipment, whose perfect homogeneity is unnecessary, calls for a considerable portion of such percentage?

So much for changes of analysis. As to results in the castings to be machined, extended experience shows conclusively that the use of acid scrap is quite unnecessary in the attainment of steel castings, most of which require machining and which are condemned on rigid railroad inspection, if not reasonably free from porosity and if not possessing physical properties in conformity with recognized specifications.

Mr. Cone has referred in general terms to some remarkable results in the physical properties of basic steel castings, as compared with those made from acid steel. This might reasonably be attributed to the greater purity of basic steel whose phosphorus and sulphur percentages are appreciably lower than can be obtained in acid practice under commercial conditions. Those who make frequent physical tests of steel representative of properly made basic castings, will testify to its excellent quality. The foundryman is interested in still another factor, namely, the ability to cast successfully in basic steel designs peculiarly susceptible to shrinkage cracks, very difficult to make in acid steel. The general character of the work produced in each foundry determines the relative importance of this

factor. We know what causes red-shortness. Some habitually, and all occasionally, require the minimum of this tendency. Here acid steel must yield to basic.

Mr. Cone's figures show a gradual tendency of acid steel to lose favor in the foundry industry. Whereas 15 years ago the percentage of acid steel was 68.4 per cent, two years ago it had fallen to 44.7 per cent. The rise to 54.7 per cent in 1915 is, in my opinion, not due to a change of preference on the part of steel founders generally, but to the scarcity and high cost of basic linings in the past two years, due to the European war. This has caused some founders to change from magnesite to sand bottoms. Probably the determination of the war will see the end of the substitution. Germany's strong leaning in the last six years to basic practice may be due to her recognized application of efficiency in all industrial lines. It may be due, in part, to the cheaper cost of basic practice in Germany, concerning which I am not informed. Local costs for linings and melting stock enter largely into this problem in any locality. But the quality of the product certainly requires no apology from the founder of basic steel castings, which are being made today in enormous quantity, of greater purity than those made from acid steel, with consequently greater shock resistance, and satisfactory to the most critical as to homogeneity.

Mr. John McKeown.—Can you get a close grain in steel which will be satisfactory for hydraulic work?

Mr. R. A. Bull.—I have not personally had any manufacturing experience in making hydraulic castings, but from my observations it is entirely possible to produce satisfactory results in castings of that kind.

The Chairman.—I might be able to answer Mr. McKeown's question; ostensibly we are car builders and our products are railroad castings, but we also build and design all of our hydraulic equipment. Our hydraulic pressure varies from 750 to 3,000 pounds, and we make all the cylinders for the hydraulic pressure out of basic open-hearth steel, 20 carbon, and we have been very successful in getting a close-grained metal. The statement has been made often that basic steel is cheaper; I think this should be modified. You can produce

the best basic cheaper than acid, but when you talk of a basic steel of equal quality there may not be a great difference in the cost, for as I view it in the acid steel process, you have only one operation, that of melting. You know at the beginning what the final analysis is going to be, at least with respect to sulphur and phosphorus, whereas in basic practice, in addition to melting, you have a refining operation during which occur the reactions which contribute to the rather comparative unsatisfactory qualifications of basic steel as compared with acid. You have the additional operation and greater care is necessary in this operation, but I am free to confess that I believe basic steel properly made is comparable in every respect to any acid steel that was ever produced.

Mr. E. F. Cone.—I wish to state, Mr. Chairman, that my object was not to favor acid steel, I simply wanted to bring out the difference without making any insidious comparisons, and I think that while perhaps Mr. Bull may be right in his statements he may have misunderstood my intentions. I also want to say that the figures Mr. Bull has given are very interesting, and I did not mean in my paper to convey the meaning that because there was a variation the steel was poor.

Mr. R. A. Bull.—There is no doubt about that.

The Chairman.—I think Mr. Cone in referring to plants that have both acid and basic, that why they did not adopt the basic if it were cheaper and possible to make just as good a steel, is that possibly their experience has been the same as that of others that it requires greater supervision and a greater nicety of operation. I know of several firms and Mr. Bull also, even in the east, that have realized this problem of geographical situation and have wanted to turn to basic, and have come to the west to get basic furnace operators to instruct them and have found that they were not in a position to change their operators to the new ideas of things, and were then forced to go back to acid, notwithstanding they recognized the quality of the steel.

Mr. E. F. Cone.—I just want to add that it seems to me a very interesting point that the particular foundry that is making basic steel out of acid scrap has not to my own experi-

ence and knowledge, had any difficulty making hydraulic cylinders; I could not check it up, but they are reported to have made such castings better than any acid foundry in the district could make them. This is a very interesting point.

Mr. John McKeown.—Is it generally contended that anything that is made of basic can also be made of acid?

The Chairman.—I don't know that I quite understand you.

Mr. John McKeown.—Anything that you make in basic, can you also make in acid, or are there some objects that you cannot make in basic that you can in acid.

The Chairman.—Well, I think possibly as you first stated it would be more nearly correct. You are able to make basic castings that you may have some difficulty to make with acid on account of the sulphur and phosphorus.

The Presence of Alumina in Steel

By George F. Comstock, Niagara Falls, N. Y.

The subject of non-metallic inclusions in steel is one that has attracted remarkably little attention among students of metallography considering the vast amount of work that has been done in recent years in the investigation of metallic structures with the microscope. Indeed the tendency is still far too common among metallographists to give the general name slag to all substances seen in polished steel surfaces that are not metal. This is especially unfortunate in regard to sulphides, which obviously are not slag, and it should be equally desirable to distinguish between other typical inclusions, such as silicates of iron or manganese, iron oxide or scale, alumina, and titanium nitride. The objects of this paper are to call attention to the fact that alumina can be distinguished from other non-metallic inclusions in steel, to indicate how it can be recognized, and to show a few examples of the harm arising from it when locally abundant.

Early References to Alumina

In the literature dealing with inclusions in steel there are but few references to alumina. One of the earliest of these, and also the most definite, with the exception of the author's work, is in an article by Heyn and Bauer, entitled "Kupfer, Zinn, und Sauerstoff", published in the *Zeitschrift fur Anorganische Chemie,* 1905, No. 45, page 63. This reference to alumina, freely translated from the German, is as follows:

"The film-like enclosures of tin oxide in bronzes bear much similarity to the enclosures in mild steel which has been deoxidized with aluminum instead of manganese. A photomicrograph, Fig. 1, shows such enclosures which consist, as found by analysis, of alumina. Also, in copper-magnesium alloys similar enclosures can be observed which are due to thin films of magnesium oxide."

Fig. 1 is a transparency copy, made by the U. S. Bureau of Standards, of the photomicrograph published by Heyn and Bauer to show the alumina inclusions, magnified 29 diameters. This same photomicrograph was used by Martens and Heyn in "Materialenkunde fur den Maschinenbau", No. 2A, page 207, from which the following is quoted and translated freely:

"A similar case (of non-metallic inclusions) can also be found in mild steel to which aluminum has been added before the deoxidation is complete. The alumina arising from the combination with oxygen is held in the metal on account of its infusibility and forms foam-like films which are visible after solidification, as shown in Fig. 1 (referring to the same photomicrograph, magnified 29 diameters, first published by Heyn and Bauer). The dark lines and specks are Al_2O_3. A steel which after solidification contains such foam-like films is not workable, but will crumble when forging at a red heat is attempted. A piece of such steel was found to be extraordinarily red-short, and when rolling was attempted it split and formed collars on both the upper and lower rolls."

Referring to the use of aluminum as a deoxidizer, and the resulting formation of alumina, Dr. Walter Rosenhain, in his "Introduction to the Study of Physical Metallurgy", page 153, writes as follows:

"A more powerful deoxidizing agent than manganese is furnished by aluminum, but this differs from manganese in two vitally important respects. In the first place, the oxidation product of aluminum is a particularly refractory substance, alumina, which has a strong tendency to remain in the molten metal in suspension as fine particles. These, of course, tend to lessen the strength and toughness of the alloy."

In a paper entitled "The Solid Non-Metallic Impurities in Steel", published in the *Transactions* of the American Institute of Mining Engineers, Vol. XLI, pages 803-822, Henry D Hibbard writes, in part, as follows:

"If other elements have been added, such as aluminum, chromium, or vanadium, their oxides and silicates may be present. * * * The too plentiful use of aluminum in steel

may have been condemned, partly at least, because it forms oxides or silicates in the metal, which, being insoluble, and infusible, exist in the solid steel as very harmful sonims. Of course, to form the oxide there must still be some oxide of iron or manganese in the steel. If the metal were free from oxygen perhaps the weakening effect of aluminum * * * would not occur."

Existence of Alumina Recognized

The various writers quoted above unmistakably recognize the existence of alumina as a frequent non-metallic impurity in steel. They are aware of the potential harmfulness of this impurity, but they do not give any idea as to how it may be recognized and identified in metallographic work. To supply this deficiency was the object of the author's article on "Alumina in Steel", published in *Metallurgical and Chemical Engineering,* Dec. 1, 1915, and also printed in the Titanium Alloy Mfg. Co.'s booklet entitled "Ferro Carbon-Titanium in Steel Making". This article described the experiments made to ascertain the characteristic appearance of alumina in steel, and showed numerous photomicrographs to illustrate it. The work will not be gone over in detail here, as the original article can easily be referred to, but some of the typical photomicrographs are shown again, and it may also be advisable to repeat the basic description of alumina inclusions and the points wherein they differ from sulphides, slag, etc.

Fig. 2 shows the inclusions in the first bar of steel that came to the author's attention, in which alumina was known to be present. These are in the form of small rounded spots, arranged close together in one elongated streak. They are of a very dark bluish-gray color, when examined with the white light of an electric arc, appearing black unless highly magnified, and it was almost impossible to polish them without forming little pits around each inclusion. If the polishing is done very carefully, these pits may be kept very small; but with certain methods of polishing the pits are made so large that the original inclusions cannot be seen at all. If the specimen is not rotated continuously during the final polishing, the pits take the form

of short scratches, and each inclusion will have a little tail like a comet. This is illustrated in Fig. 3, while Fig. 4 shows the same streak of alumina particles after grinding and more careful polishing.

Fig. 5 shows another bar of steel, like Fig. 2, in which the occurrence of alumina was assured, and the general similarity of form in these two instances is apparent. Although these both show longitudinal sections of forged bars, the individual inclusions have not been elongated by the forging, but merely the groups of particles have been drawn out into streaks. Compare these with Figs. 6 and 7, showing silicates in rolled bars, and a great difference is evident at once, for the individual silicate particles are very much elongated in the direction of rolling. It should perhaps be noted here that there is no difference between rolling and forging in their effects on either alumina or silicates.

Differences Between Alumina and Other Inclusions

The differences between inclusions of alumina and ordinary slag or silicates in steel were summarized as follows: (1) Silicate inclusions will generally take a fairly smooth polish in a section prepared for microscopic examination, while alumina is very hard to polish without pitting. (2) Silicate inclusions are always elongated in the direction of rolling or forging, while alumina particles are not. The groups of particles are of course elongated, but not the particles themselves. (3) Silicate inclusions are often found of quite large size, as well as very small, while particles of alumina are always small, and do not seem to coalesce into large bodies even when closely grouped together. These characteristics of alumina inclusions agree with what is known of the properties of alumina. Its great hardness and brittleness would account for the pitting effect; its infusibility would account for the small size of the particles and the tendency not to coalesce; and both of these properties together would account for the particles not being elongated by forging or rolling of the steel in which they are embedded.

It was brought out in my former article, previously mentioned, that no other substance was known to me that had

exactly the same appearance as alumina in a polished steel section, and this statement still holds true. Fig. 8 shows some complex slag inclusions, probably containing titanium, since the steel was treated with oxide of titanium before casting. Evidently it cannot be said that this oxide looks like alumina. Fig. 9 shows oxide of chromium embedded in steel. These resemble alumina slightly in a photograph, but when seen directly through the microscope they may be distinguished by their smooth polish and purplish color. Fig. 10 shows the inclusions in steel treated with nickel oxide. These are probably oxide of iron, and could not be mistaken for alumina. Titanium nitride crystals are easily identified by their angular form and pink or orange color, which is shared by no other substance in steel. The differences between silicates and alumina have been pointed out above, and sulphides are of course known to nearly all metallographists by their smooth dove-gray appearance. Thus the appearance of alumina is believed to be distinct, and warrants the identification of this substance in steel by metallographic examination.

The author's work in establishing this identification was based largely on checking the microscopic evidence by chemical analyses. It was stated in the previous article that all samples in which more than the merest trace of alumina was found by analysis were seen to contain the typical inclusions as described above, and those in which alumina was not found by analysis, did not contain these inclusions. Furthermore, those in which more alumina was found by analysis contained more of these inclusions than those in which only a very little was found. It might perhaps be well to mention the fact that these analyses were not made under the author's direction, but in a different laboratory, and neither the chemist nor the metallographist knew each other's results until the work of both on any given sample was completed. The methods used in the chemical determination of alumina in steel are described in the booklet "Ferro Carbon-Titanium in Steel Making", pages 99 to 105, and in the course of his remarks on the chemical side of the work, the writer, L. E. Barton, states that "the results show con-

clusively that alumina may occur in the free state in steel, and greatly strengthen the probability that free alumina may be detected by metallographic examination."

Investigation by Sauveur

The well known metallographist, Prof. Albert Sauveur, of Harvard University, has recently completed an independent investigation dealing with the occurrence of alumina inclusions in steel, in the course of which he examined some of the author's specimens as well as some that he himself prepared. His report of this work was published in the Aug. 1, 1916, issue of *Metallurgical and Chemical Engineering* and in the *Iron Age* and *Iron Trade Review* for July 27, 1916. Fig. 11 included below, is a photomicrograph taken by Prof. Sauveur of the same sample shown in Fig. 5, but magnified only 36 diameters. It illustrates well the "filmy" arrangement sometimes assumed by alumina particles, as mentioned by Martens and Heyn, quoted above, and represented by Heyn and Bauer in Fig. 1. A comparison of Figs. 11 and 5 indicates that the "dark lines" said to be Al_2O_3 in Fig. 1, which is magnified only 29 diameters, were in all probability made up of fine rounded particles like those described by the author and shown in Figs. 2 and 5. The conclusion reached by Prof. Sauveur was that "alumina inclusions may be distinguished under the microscope from the other inclusions generally occurring in steel, being characterized by their small size, their dark coloration, and more especially by a complete absence of elongation in the direction of the rolling or forging."

Identifying Alumina in Cast Steel

To a foundryman it may appear that the characteristic appearance of alumina inclusions, as compared with slag or silicates, is only exhibited in worked steel, but this is not the case. The identification of alumina in cast steel calls for more care and experience than in worked steel, for small silicates here exist as globules instead of fibers, and might perhaps be mistaken for alumina if carelessly polished and examined. But the very dark color of alumina, its rough appearance and the pitting effect, and the invariably small size of the individual

particles are sufficiently distinctive characteristics to enable it to be recognized in castings as well as forgings, especially if the observer is careful and already familiar with its appearance. Fig. 12 shows these inclusions in a casting of soft steel, where the presence of free alumina was established by chemical analysis of the insoluble residue from a large sample. Fig. 13 shows a fairly typical though large slag inclusion in another casting, and the sharp outlines of the slag, as compared with the rough appearance of the alumina, are clearly brought out. This slag, moreover, as is often the case, is evidently not homogeneous, but of duplex composition. Fig. 14 shows a section near the extreme top of an ingot, where the alumina content was excessively high. This foamy appearance is rare, but to a certain extent it resembles Fig. 1, as described by Martens and Heyn. The usual aspect of alumina in cast steel is the same as in forged or rolled steel, with the single exception that when the particles are grouped closely together in certain spots, these groups are of irregular or rounded shape in castings, instead of being elongated into streaks as in a rolled bar.

A similar difficulty to that experienced in castings may be encountered in cold-worked steel, such as wires, tensile test bars after pulling, etc. Here the slag or silicate fibers are usually broken up into fragments and drawn out into streaks, but if carefully polished the fragments of silicates can be recognized by their definite and angular outlines and their smooth surface, while alumina particles will be rougher, probably more or less pitted, and less distinctly outlined.

It is not desired to give the impression by this paper that alumina always exists in steel in the form of such large groups of particles as those shown in the photomicrographs. Its most usual mode of occurrence is probably in isolated particles, thinly scattered through the metal, and in this form it is practically harmless. The danger in its use as a deoxidizer lies in the fact that with our present knowledge, or under present mill conditions, we can never be sure that the alumina particles will not segregate or gather together in certain parts of the casting or ingot. When this happens the results are dangerously weak streaks such as is shown in part in Fig. 15, taken from a bloom

intended for structural steel. Such streaks may not be common, but they nevertheless do occur when aluminum is used, and may cause great harm. A few examples will be mentioned in closing where failures in service could be directly traced to the presence of alumina.

Service Failures Due to Alumina

Fig. 16 shows a group of alumina particles near the starting point of the fracture of a large driving tire on a railroad locomotive. No other defect could be found to explain the failure, except the presence of too much alumina, segregated in spots through the metal. Fig. 17 shows part of a streak of alumina and sulphide particles that caused the top of the head of a rail to break and shell off in the track. The contrast in appearance between alumina and sulphides is well brought out in this photomicrograph. Fig. 18 shows a section of a thin steel plate, on which blisters appeared after hot-rolling. A large streak of alumina was found near the surface of the plate, and part of this streak is shown in the photomicrograph. The black strip along one edge is space beyond the edge of the section, or beyond the surface of the plate, and the other long black spots are sections of blisters, the bright areas being, as in all the other photomicrographs, the polished surface of the steel. The metal evidently tore through the alumina streak, as the blisters are seen to lie in it, and the contraction of the hot interior of the plate after rolling caused the cooler outside layer to bulge outward, forming blisters where the separation or tearing in the alumina had taken place.

Before closing, it should be mentioned that all the photomicrographs, except Fig. 1, copied from a tracing by the Bureau of Standards, and Fig. 11, taken by Prof. Sauveur, were made at a magnification of 200 diameters, and no etching reagent was used. The author desires to express his thanks to the Bureau of Standards and to Prof. Sauveur for help received from their correspondence in obtaining the references to the previous literature on this subject, and his thanks are likewise due to the chemical staff of the Titanium Alloy Mfg. Co., without whose co-operation the certain identification of alumina inclusions could not have been made.

FIG. 1—ALUMINA IN STEEL DISCOVERED BY HEYN AND BAUER

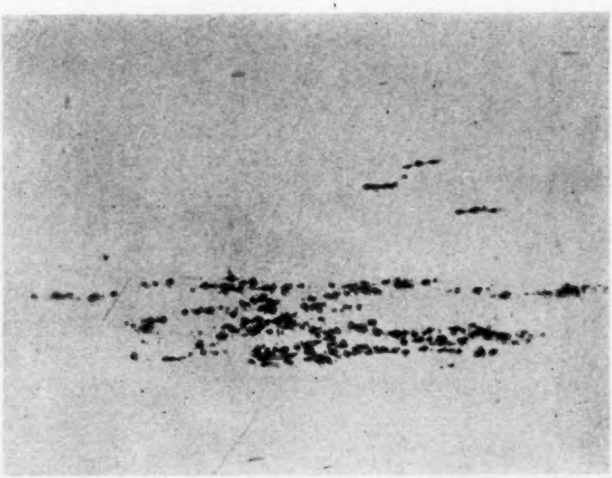

FIG. 2—INCLUSIONS IN STEEL KNOWN TO CONTAIN ALUMINA

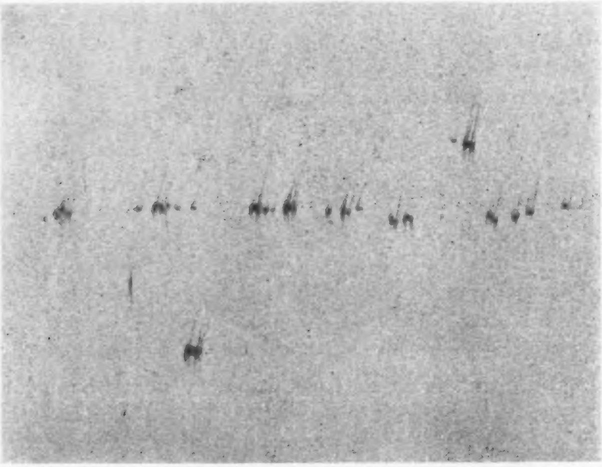

FIG. 3—ALUMINA PARTICLES BADLY POLISHED, SHOWING SHORT SCRATCHES

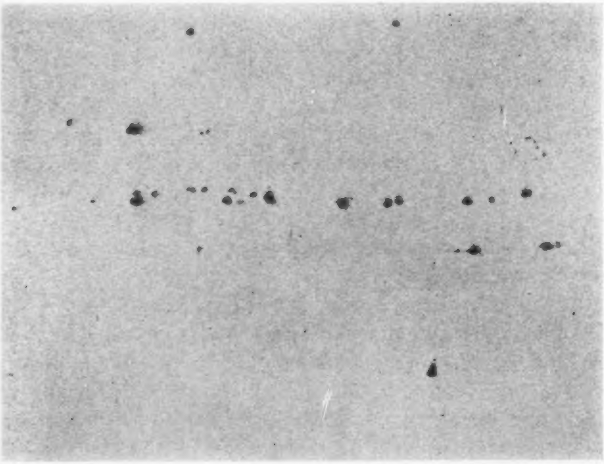

FIG. 4—SAME STREAK OF ALUMINA PARTICLES AS SHOWN IN FIG. 3 AFTER GRINDING AND MORE CAREFUL POLISHING

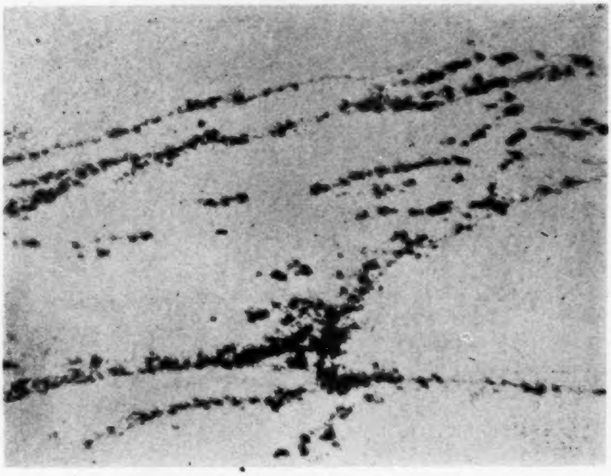

FIG. 5—BAR OF STEEL SHOWING CHARACTERISTIC ALUMINA INCLUSIONS

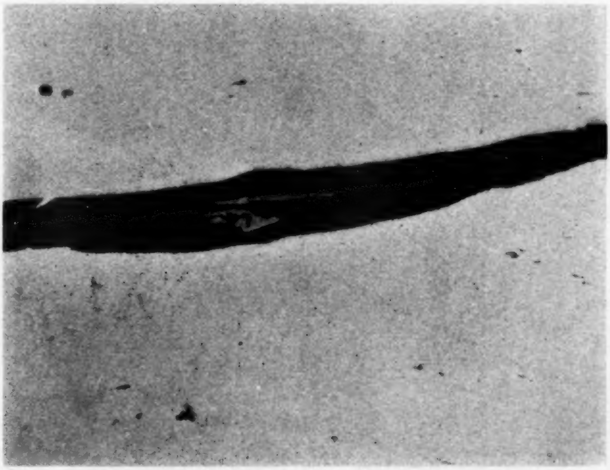

FIG. 6—TYPICAL SILICATE INCLUSION IN ROLLED STEEL BAR

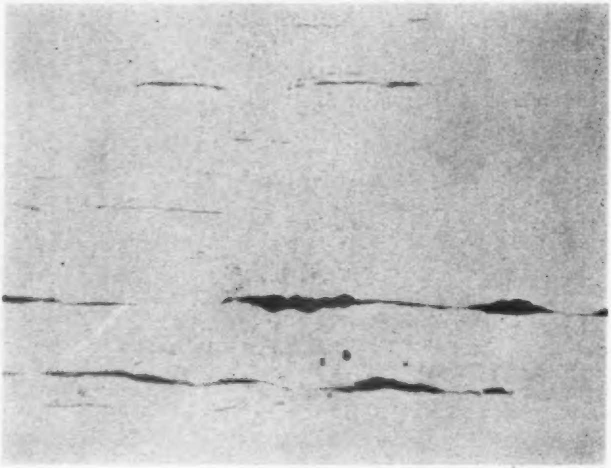

FIG. 7—ANOTHER EXAMPLE OF SILICATE INCLUSIONS

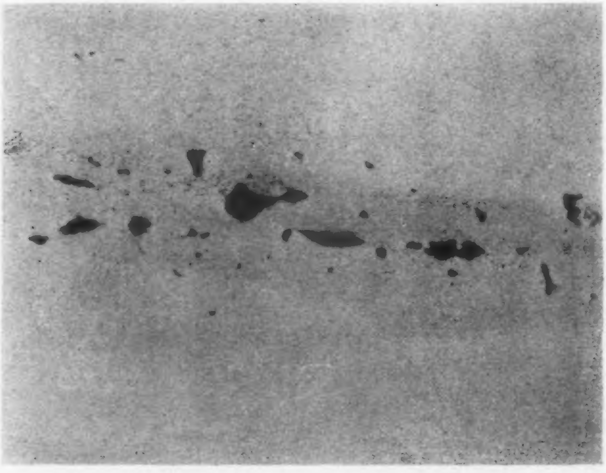

FIG. 8—COMPLEX SLAG INCLUSIONS IN STEEL

FIG. 9—CHROMIUM OXIDE EMBEDDED IN STEEL

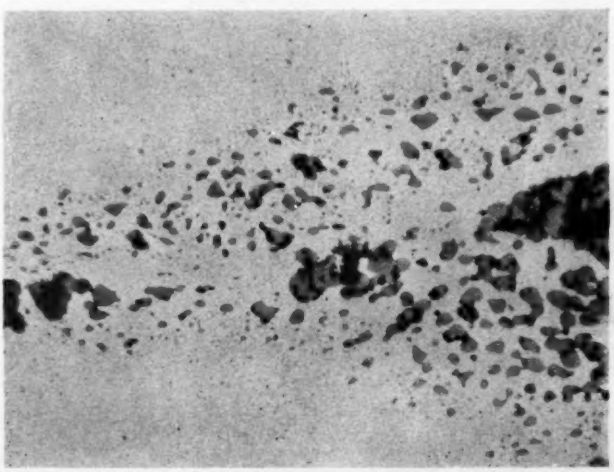

FIG. 10—INCLUSIONS IN STEEL TREATED WITH NICKEL OXIDE

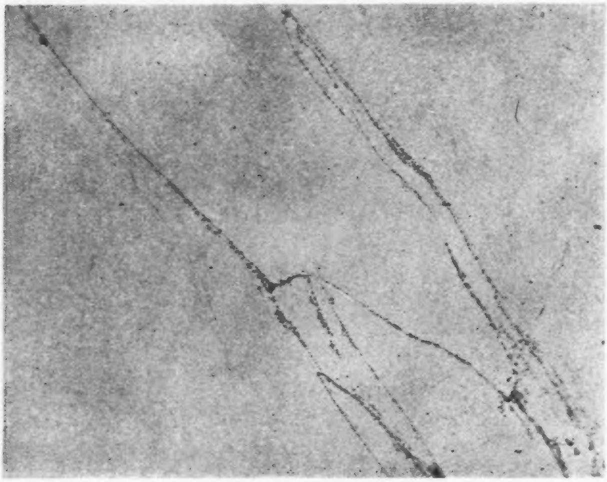

FIG. 11—ALUMINA PARTICLES IN SAME SAMPLE AS SHOWN IN FIG. 5 BUT MAGNIFIED LESS (Sauveur)

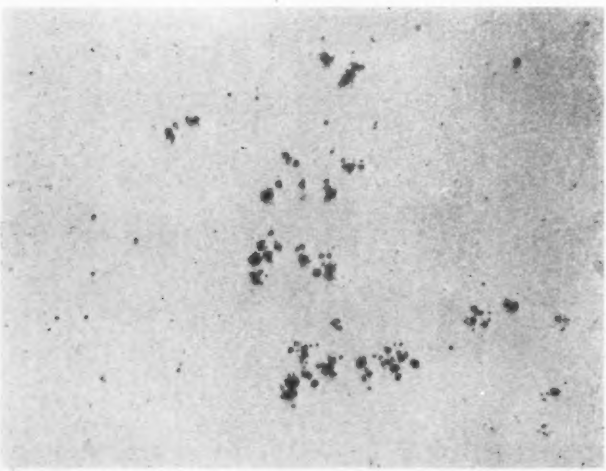

FIG. 12—ALUMINA INCLUSIONS IN A SOFT STEEL CASTING

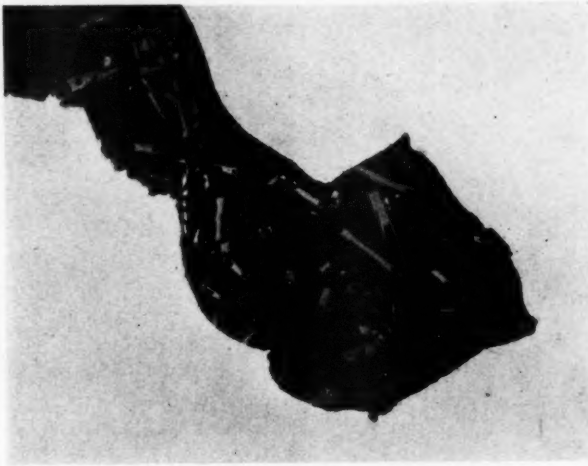

FIG. 13—LARGE, TYPICAL SLAG INCLUSION IN STEEL CASTING

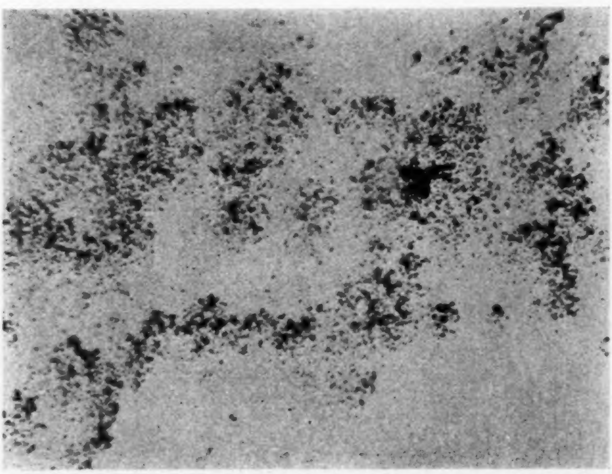

FIG. 14—SECTION NEAR TOP OF AN INGOT WHERE ALUMINA CONTENT WAS UNUSUALLY HIGH

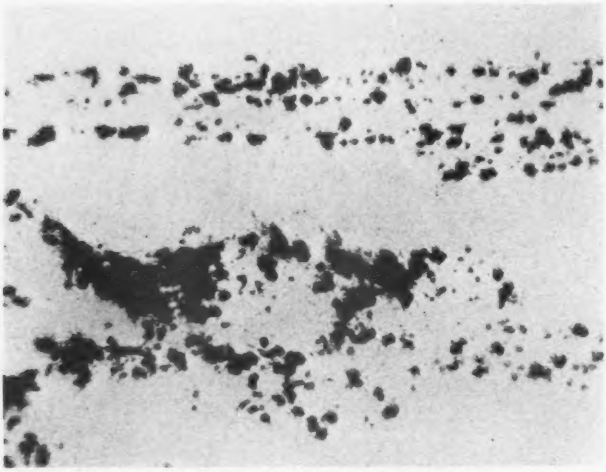

FIG. 15—WEAK STREAKS OF ALUMINA PARTICLES IN A STRUCTURAL STEEL BLOOM

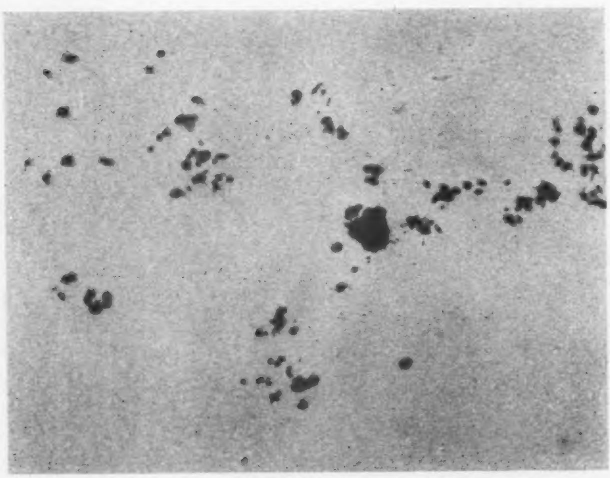

FIG. 16—ALUMINA INCLUSIONS NEAR FRACTURE IN LOCOMOTIVE TIRE

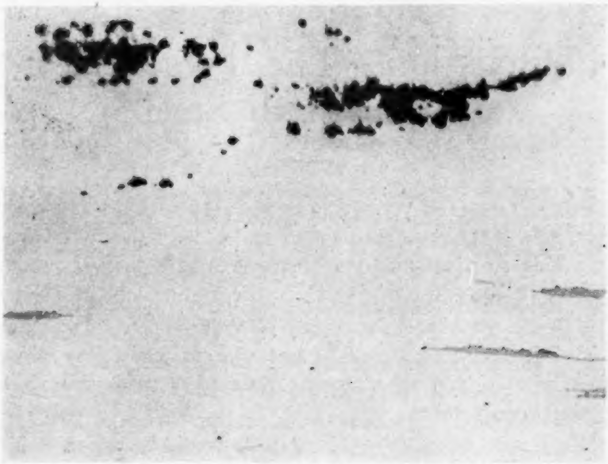

FIG. 17—ALUMINA AND SULPHIDE PARTICLES IN A FAILED RAIL

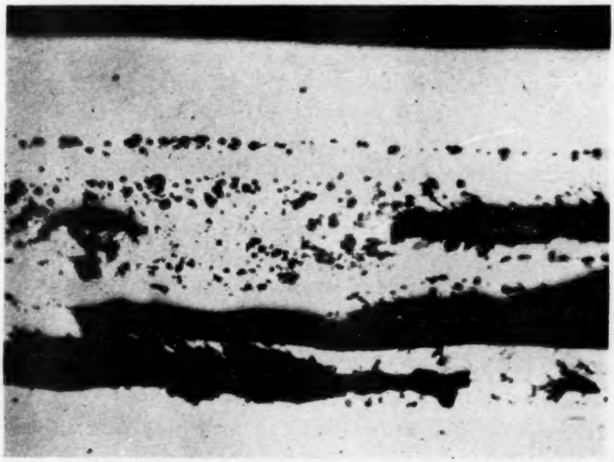

FIG. 18—SECTION OF A THIN STEEL PLATE, SHOWING BLISTERS AND STREAKS OF ALUMINA

Discussion—The Presence of Alumina in Steel

The Chairman, W. A. Janssen.—This is a most interesting paper. As Mr. Comstock pointed out, these streaks or particles of alumina so often manifest themselves as a line of weakness and may be the cause of failure in the casting and its rejection. Is there any discussion on this interesting subject?

Mr. J. S. Morrow.—I would like to know the physical causes of this, and whether any tests were made from which the plates were taken.

Mr. G. F. Comstock.—The defects would be apparent in the test bar and the piece would not be tested. Where there are just small particles of alumina I don't think that would be bad, because almost all metal contains sulphide and the effects would not be any greater than the small particles of sulphide, but the bad effects are brought about by tendency to segregate and form into streaks, which are the causes for very apparent failures.

Alloy Steel Castings

By David Evans, Chicago

The title of this paper may be considered as the gate to a very large field. As I do not possess the equipment necessary to explore it very thoroughly I may be excused, therefore, if I am found swinging on the gate most of the time. The first move I made in an attempt to get together some reliable data on the subject, was to address a number of letters to different foundries in the east, the central west and the west, inquiring whether they made alloy steel, what alloys they used, how they used them, etc. Great care was taken to include in the letters to each section, foundries using the open hearth process, the converter, the crucible, the electric, or combinations of these processes.

The replies were somewhat disappointing. Only 50 per cent of the inquiries were answered at all. Of those that did answer, 50 per cent did not make alloy steel. The foundries that answered in the affirmative were largely converter plants, which would seem to indicate that the converter process holds first place in the manufacture of special alloy steel castings. This conclusion is not confirmed by the figures of the American Iron and Steel Institute, however, which gives first place to the acid open hearth process, nearly three times as much alloy steel being made by that process as all the others put together. These figures will be referred to later on.

All of this delving around among other foundries did not appear to reveal much information of any value, so we are left to the meager experience we have had in our own plant, plus some help from the publications issued from time to time by the different manufacturers* of alloys. These last have proved very useful and we hereby tender our thanks to the authors.

To get down to the meat of the subject, alloy steel is a term used to denote any steel that contains any alloy other than the

*The Titanium Alloy Mfg. Co., American Vanadium Co.

usual elements found in all steel—carbon, manganese, silicon, phosphorus and sulphur. Thus we have manganese steel, vanadium steel, tungsten steel (although tungsten is not used in making steel castings), nickel steel, and titanium steel. The last is not really an alloy steel in the proper sense of our definition, but simply an alloy used in the manufacture of steel. Titanium is coming into such general use, however, that some mention of it seems entirely proper in connection with other alloys.

As manganese steel will be discussed in another paper no consideration will be given to it in this paper, but we will take up the other alloys mentioned and attempt to separate them in the order of their behavior when they are added to the charge.

The Function of Titanium

We mention titanium first because it disappears entirely when added to the charge. Its value then is entirely as a flux. It is used in several different forms depending on the process used by the steelmaker. Assuming that the steel is properly made in the furnace, converter or crucible and is ready for the addition of the alloys, the 50 per cent ferro-silicon is first added, followed immediately by the titanium, four to six pounds of the alloy to a ton of steel being recommended. In open hearth practice from six to eight minutes should elapse between the addition of the titanium and the pouring of the first mold, but in the converter practice this may be reduced to three or four minutes. This time is sufficient for the slags and oxides to rise to the surface. The oxidation of titanium is a heat-producing reaction, so there will be no danger of chilling the steel by holding it for a few minutes in the ladle. We have noticed in converter practice that the steel usually comes from the converter too hot to be poured anyway, and a few minutes' wait is necessary, whether alloys are to be added or not. Titanium has proved itself a safer deoxidizer, as in the use of aluminum the tendency on the part of the pouring gang to use too much, often results in the formation of alumina in the finished steel. There is an erroneous idea among some steel men that titanium prevents the formation of

blow holes in steel and that it was first used in the manufacture of rail steel to prevent piping in ingots. It was first so used, but its action is to prevent the formation of a vast number of blow holes throughout the ingot and to concentrate all of them in one place near the top, which is a distinct benefit of course.

We have found this alloy of great benefit in pouring thin sections where clean, hot metal was especially desired and where the maximum of strength was required. The high price of and great difficulty in securing aluminum during the past year or more have done much to establish titanium in the steel foundry as no mean substitute.

Vanadium

The use of vanadium in steel is an instance where the trade responded to pressure from the outside to produce a steel that would combine the maximum of strength and reliability with the minimum of weight. The metal has been known to scientists for over 100 years and to none but scientists for about 90 years of that hundred. There were more or less unsuccessful attempts to use vanadium in the manufacture of armor plate in France as early as 1896, but Prof. Arnold's discovery, in 1900, that 1.25 per cent carbon steel with 3 per cent vanadium would cut 75 per cent more than the same steel with 3 per cent tungsten marks its real entry into metallurgy.

Ferro-vanadium has been on the market regularly since 1906 and has increased in popularity with each year. If I mistake not it first came into general use in the manufacture of steel for automobiles. The motor car manufacturers furnished the demand or outside pressure, and the steelmakers met it with vanadium steel. It was advertised as "anti-fatigue" steel, because of its wonderful resistance to vibration, but it is now known that it imparts qualities to any steel that make it better for any purpose.

It is not going too far to say that any steel is better for the addition of vanadium, but the full value will not be realized unless the steel is properly annealed. When ferro-vanadium

is added to steel it goes immediately into solution. Through its affinity for oxygen and nitrogen it combines with those gases, when they are either free, or united with other elements by a bond that is weaker than that of vanadium. This deoxidizing effect, however, is purely incidental and where it takes place to such an extent as to cause excessive loss of the alloy in the finished steel it is an indication that the steel was not properly deoxidized in the first place. To this extent it performs the same office as titanium, or aluminum, but is far too expensive to be used for this purpose alone.

The practice seems to be fairly uniform among steel founders as to the amount of vanadium necessary to add, usually 0.10 to 0.20 per cent. It is claimed that this alloy has a peculiarly intensifying effect on the other elements present in all steel, or on other special alloys added, such as chromium, nickel, tungsten, etc. The writer has personally poured test bars from crucible steel without vanadium, then added to the remainder of the metal left in the pot 0.14 per cent vanadium (estimated) and secured test bars having over 8,000 pounds greater tensile strength, with a marked improvement in the appearance of the grain.

Vanadium in Dies

To take an opposite example, one of our large customers experienced great trouble from die breakage. The dies were cast iron. We tried making them in cast steel (0.15 to 0.20 per cent vanadium and about 0.40 per cent carbon) with unusually satisfactory results. It had been the practice of this customer to make his own dies and it took considerable argument to get him to buy cast steel costing three times as much, but it was soon found that the cast steel dies outlasted the iron dies nine to one, and that the time saved in replacing broken dies alone covered the cost of steel. Another instance is in locomotive engine frames, once so prolific a source of accidents. The breakage has been largely overcome through the use of vanadium cast steel frames and such steel is now standard with several of the large railroad systems. A list of articles where the use of vanadium steel would be an advantage would include practically everything in the steel

line. It is indeed hard to imagine any steel that is not made better by its use.

Whereas we have seen that titanium disappears entirely when added to molten steel, and is valuable entirely as a flux and that vanadium disappears only in part and to such an extent is a flux as well as an addition, we now come to nickel, which is used entirely as an addition. The percentage of nickel added at the beginning is present in the finished steel. It loses nothing by oxidation. Some authorities say it may be added to the charge in converter practice at the beginning of the blow and that every particle of the metal so added will be found in the finished steel. Personally I have never tried this. With nickel at 50 cents a pound it looked too much like tempting fate. Nickel has held a very high place in steel-making for a great many years and there is a pretty constant demand for steel containing 3½ per cent nickel. The higher percentages, 10 per cent and 20 to 25 per cent are not very frequently specified, although at various times we have made such articles as valve stems, discs and valve seats and other fittings, where the chief requisite was ability to withstand corrosion, using 20 per cent nickel in the steel.

Times Have Changed.

Time was when steel founders as a rule did not care to bother with special steels, particularly the men in charge of the larger plants. The time of the management was fully taken up with the regular conduct of the business and every day brought its own peculiar problem to be solved, without inviting additional work such as would be involved in the manufacture of special steels, but a glance at the following figures from the special statistical bulletin No. 3 for the year 1916 issued by the American Iron and Steel Institute, will show that a decided change has taken place. The total tonnage of alloy steel ingots and castings produced in the United States, including the District of Columbia and the Panama Canal Zone, for the year 1915 was 1,021,147 tons. Something less than 10 per cent of this total tonnage was steel castings, or 97,896 tons. As the bulletin makes no mention

of manganese steel it is probably included in the tonnage of alloy steel castings. Tabulated by processes the figures for the alloy steel castings are:

	Tons
Open hearth steel (basic)	1,796
Open hearth steel (acid)	71,263
Bessemer steel	23,900
Crucible steel	841
Electric steel	96
Total	97,896

These are impressive figures and when I look at them I am reminded of a little conversation I had some years ago with an old time steel founder. I had secured an order for alloy steel and was making a few well directed inquiries among older and more experienced steel founders as to the best practice, etc. I ran across an old steel foundryman and got him to tell me how he made nickel steel. He said his method was to open the charging door just before the heat was ready to tap out and throw in a five cent piece. He said it was the best method he had ever tried and that it had never failed to work.

While to the casual observer this method may have appeared somewhat crude, there is nothing to indicate that the old time foundryman allowed his distaste for alloy steel to make him so far forget himself as to refuse an order. This instance is interesting because it is one of many that mark the progress of the steel foundry industry during the past decade.

Report of A. F. A. Committee on Specifications for Steel Castings*

On taking up the work of this committee, your chairman, acting in co-operation with your president, Mr. R. A. Bull, enlarged the committee by the addition of several members. A copy of the last report of the committee, giving recommendations for changes in the standard specifications for steel castings, published by the American Society for Testing Materials, was sent to each member of the committee, with the request that he give his opinion on the proposed changes, point by point.

With this information in hand, your chairman held a conference with Mr. Thomas, the chairman of the Steel Founders' Society committee on steel castings, who was provided with the views of the members of his committee on the proposed changes. Your chairman and Mr. Thomas then requested committee A-1 of the American Society for Testing Materials to call a meeting of its sub-committee on specifications for steel castings to consider these changes. Your chairman and Mr. Thomas attended this committee meeting, and did their best to secure the adoption of such changes as met the views of the majority of the two committees.

The results obtained can be best set forth by taking up the proposed changes one at a time, and stating the final action secured, or the reason for not securing action.

The changes secured were acted upon favorably by the full committee A-1 of the American Society for Testing Materials, and at the recent convention of that society these changes in the specifications were approved and referred to the membership of the society for letter ballot. When the result of the letter ballot is ascertained, these changes will be finally accepted or rejected.

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*This report containing amendments to the original standard specifications for steel castings, published on page 458 of Vol. XXIV of these *Transactions*, was adopted unanimously.

The wording of Section 5-D was changed from its old form to the following form:

Class B castings shall be properly annealed, the treatment depending upon the design and chemical composition of the castings.

The changes proposed in section 6, as embodied in the former report of this committee, were not satisfactory to the majority of the members of the committee as now constituted, nor were they satisfactory to the membership of the Steel Founders' Society committee. After somewhat protracted discussion at the meeting of the sub-committee on steel castings of the American Society for Testing Materials, it was voted to leave this section and Section 23 in their present form.

The change proposed in Section 7, to add silicon to the list of the elements to be analyzed, was not satisfactory to the membership of your committee, nor to that of the Steel Founders' Society committee, and we did not recommend any action on this to the American Society for Testing Materials.

The changes proposed in Section 9-A with reference to physical properties and tests of Class B castings were satisfactory to the membership of both committees. Your chairman regrets to state, however, that the American Society for Testing Materials took action on only one-half of these recommendations. Their action was to specify that the elastic limit, or rather the yield point, for all grades of castings should be 45 per cent of the tensile strength. The efforts to have them specify that the percentage of elongation in 2 inches shall equal 1,400,000 divided by the tensile strength per square inch failed, and no action was taken on this recommendation.

Section 11 has been amended to read as follows:

In the case of small or unimportant castings, a test to destruction on three (3) castings from a lot may, upon agreement between the manufacturer and the purchaser, be substituted for the tension and bend tests. This test shall show the material to be ductile, free from injurious defects, and suitable for the purpose intended. Unless otherwise agreed upon between the manufacturer and the purchaser, a lot shall consist of all castings from one melt, in the same annealing charge.

The addition proposed to Section 12 was to read as follows:

"When desired by the purchaser suitable test lugs shall be cast on castings which do not have test bars attached, so that the inspector may judge of the annealing."

This proposed addition was not satisfactory to the membership of your committee, nor to that of the Steel Founders' Society. Certain members of the sub-committee on steel castings of the American Society for Testing Materials were anxious that this addition should be made, and the action that was finally taken at the meeting of their committee was the appointing of a sub-committee of their sub-committee on steel castings to report next year on the advisability of this step. At present no action has been taken.

The change proposed in Section 12-C—"Or have turned grips at the option of the manufacturer" which was desired by the membership of both committees in order to legitimatize the use of test bars with plain turned ends, was taken care of by the action of committee A-1 of the American Society for Testing Materials in changing their specification for test bars to allow either a threaded end test bar or a test bar with plain turned end. This change applies to all their specifications for steel. The full text of their new specification is as follows:

Tension test specimen shall conform to the essential dimensions shown in Fig. 2. They shall have filleted shoulders, or threaded ends, to fit into the holders on the testing machine in such a way that the line of action of the force exerted by the testing machine shall coincide with the axis of the specimen.

A new section, No. 14, has been inserted following Section 13. This section reads as follows:

If the results of the physical tests of any test lot do not conform to the requirements specified, the manufacturer may re-anneal such lot not more than twice, and re-test shall be made as specified in Sections 9 and 10.

A slight change has been made in Section 15-C which now reads as follows:

Castings shall not be offered for inspection if covered with paint, rust, or any other substance to such an extent as to hide defects.

Your chairman regrets the inability to secure action at this time changing the allowance for sulphur in castings, but feels that this matter will take care of itself in the immediate future, and that within a year or two action upon this point will probably be forced by the pressure of circumstances. He regrets also that the American Society for Testing Materials was unwilling to change its specifications for elongation as requested by this society, but in general he feels that the changes secured are sufficiently satisfactory to warrant him in recommending that the American Foundrymen's Association use the specifications of the American Society for Testing Materials as now amended rather than endeavoring to get up specifications of its own.

John Howe Hall, Chairman.
W. C. Hamilton.
A. H. Jameson.
Arthur Simonson.

Theory and Practice in Gating and Heading Steel Castings

By Ralph H. West, Cleveland

In accepting the subject of this paper for presentation before this society, I must first state that my remarks are based on my own practice and experience. They are offered in order to stimulate discussion so that in the end the trade may receive some valuable data, to be used in a later compilation. I am aware that the subject is a very broad one, presenting many angles, but for the present we must be content with such data as can be produced relative to general castings and steel foundry practice. As the business with which I am now connected deals mostly in light and medium weight castings, I shall of necessity confine my discussion to this field, including general work weighing from one pound up to 500 pounds.

Theory is Developed From Experience

We are to discuss theory and practice. All arts have been founded on practice, and time gives experience. It is only through this experience that we are able to form any theory.

The steel founder receives an order from a customer for steel castings. This order may be for one or 100 castings, involving a like number of methods of procedure. As a quantity order may necessitate machine molding with intricate rigging, I shall confine my present remarks to the small order problem. The first question which confronts the foundryman is how he can most economically and practically produce the steel casting required, to the satisfaction of both his customer and the company. This problem involves two main factors—the mold and the liquid metal, the case at hand being molten steel.

In order that the molten steel may enter the mold, we must provide a pouring hole or gate, so that the mold will receive

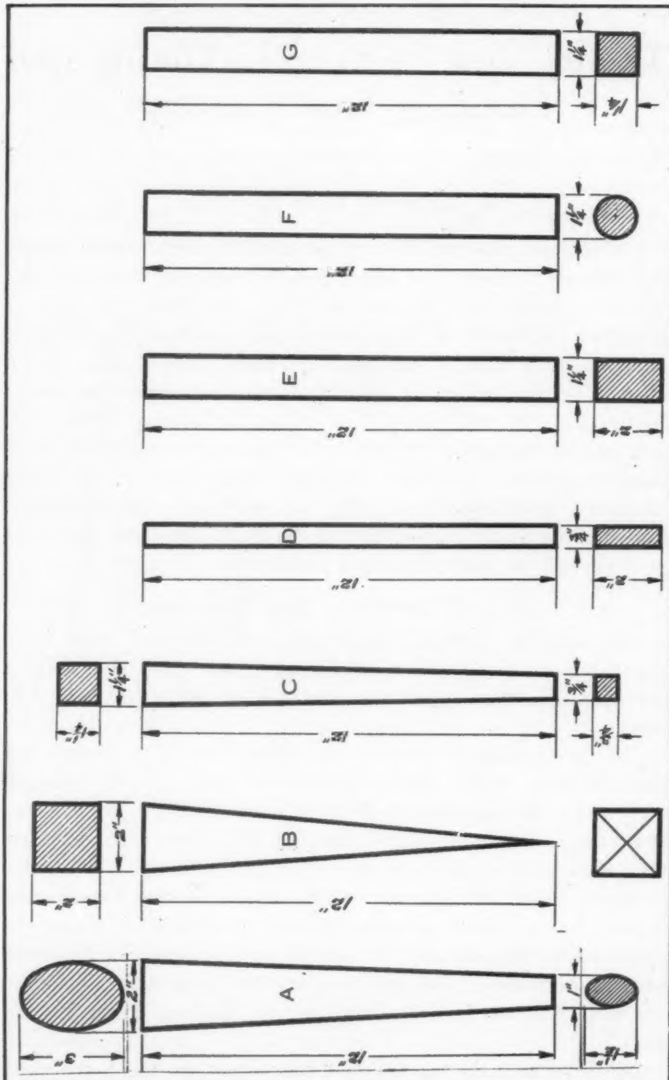


FIG. 1—DIAGRAM OF OPEN MOLD TEST BARS SHOWING SIZES

the metal as rapidly as required, according to the size and section of the piece being made. The gate also should be arranged so as not to interfere in any way with the production of a perfect casting.

The temperature of the molten steel varies; therefore practice determines the conditions governing size of gate. But the location of the gate in the mold must be determined by knowledge and practical experience. After the steel foundryman has determined the best location for his gate, he must then consider the problem of shrinkage. Molten steel in passing from the

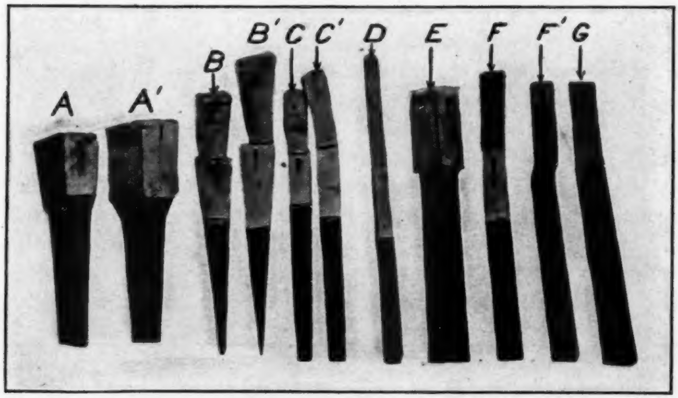


FIG. 2—TEST BARS WITHOUT HEADS SHOWING SHRINKAGE

liquid to the solid form will shrink from 3/16-inch to 1/4-inch per foot of length. The foundryman, therefore, must provide practically all steel castings with some form of a reservoir to feed or take-up the shrinkage as it develops, so as to form a solid casting. This feeder or reservoir is commonly called a head.

Green sand has a natural bond, and presents a greater chilling action to the liquid steel than dry sand, thus requiring in most cases a lesser percentage of metal in the head to feed the casting or to offset the shrinkage. I am assuming that my readers understand that a dry-sand mold is simply a green sand mold with a special facing, placed in an oven and dried

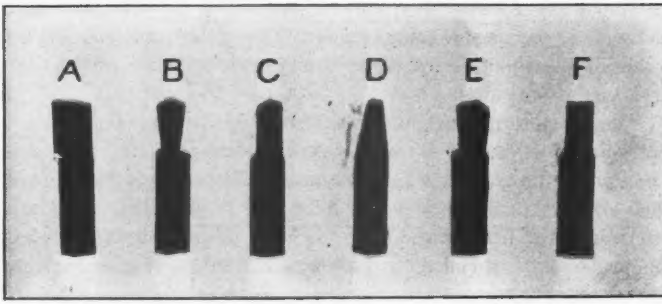


FIG. 3—TEST BARS WITH SIX DIFFERENT FORMS OF HEADS

or baked so as to eliminate the moisture, thus presenting a better surface to the molten steel for final results.

As the shrinkage problem varies according to the shape and form of the casting as well as according to its sections, we shall present some standard forms of test bars to illustrate various shrinkage phenomena. For the purposes of comparison, and in order to properly classify and possibly theorize with respect to different sections of castings, the shapes and sections of test bars shown in Fig. 1 were selected. The test bars

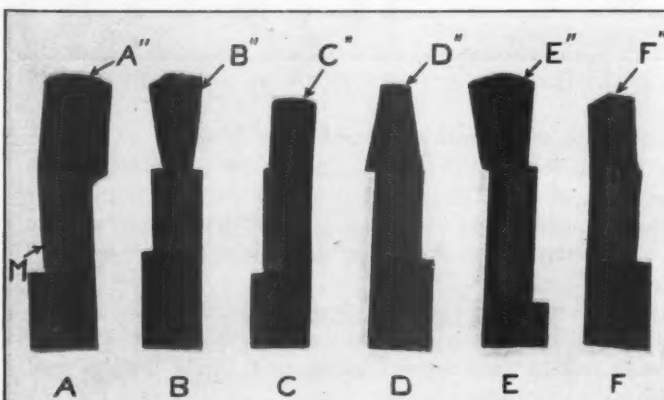


FIG. 4—TEST BARS WITH VARIOUS FORMS OF HEADS CAST IN DRY SAND

were molded in both green and dry sand. They were poured from the top, without any gate and with no extra head. This is commonly known as an open mold, poured through the head and cast on end. Test bars *A, B, C,* etc., Fig. 2, were cast in dry sand. Test bars *A′, B′, C′*, etc., were cast in green sand. There is a very strong contrast in the shrinkage cavity due to the different chilling or cooling effects of the molds. Note especially test bars *C* and *C′*. This is a common section and one that can in most cases be cast without a feeding head. The green sand mold shows practically a solid bar. Taking the

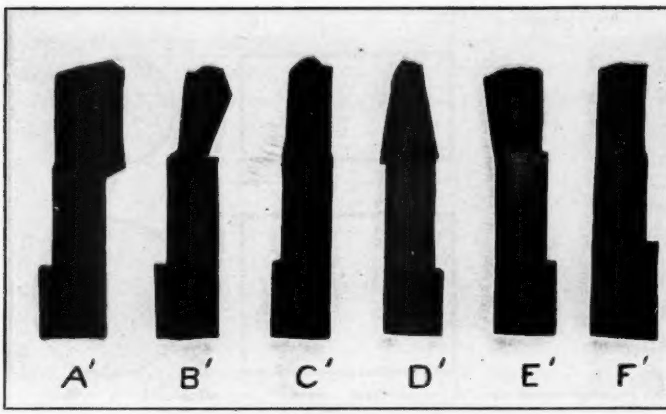


FIG. 5—TEST BARS SIMILAR TO THOSE SHOWN IN FIG. 4 CAST IN GREEN SAND

various sizes of test bars, it becomes very evident that any section 1-inch or over requires some form or means of feeding to avoid porosity. It is also true that all shrinkage remains in the top of properly molded and poured castings.

The next set of tests, shown in Figs. 3, 4 and 5, covers standard test bars with different forms of heads or feeders, such as may be found in all steel foundries. Fig. 4 shows bars cast in dry sand and Fig. 5 those cast in green sand. Fig. 6 gives the dimensions of the heads and of the test bar which is shown at *M*. This bar contains 32 cubic inches. Head *A″*, Fig. 6, contains 28 cubic inches; *B″* and *D″*, 10 cubic inches;

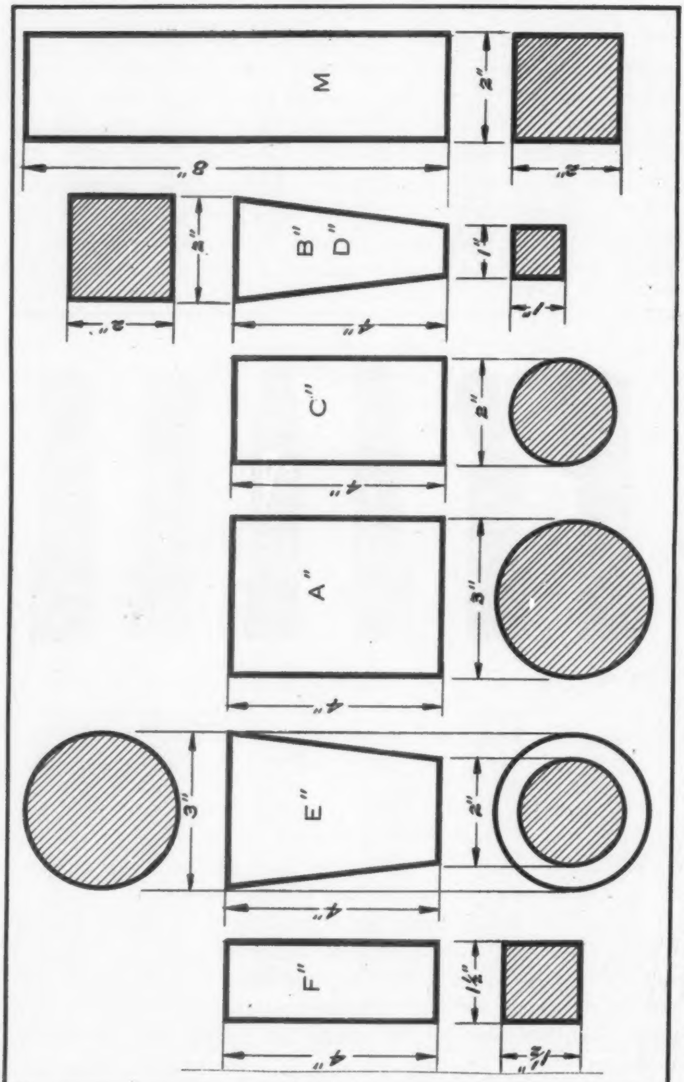


FIG. 6—DIAGRAM OF SHRINK HEADS SHOWING SIZES—DIMENSIONS OF TEST BAR ARE SHOWN AT M.

C'', $12\frac{1}{2}$ cubic inches, E'', $20\frac{1}{4}$ cubic inches, and head F'', 9 cubic inches.

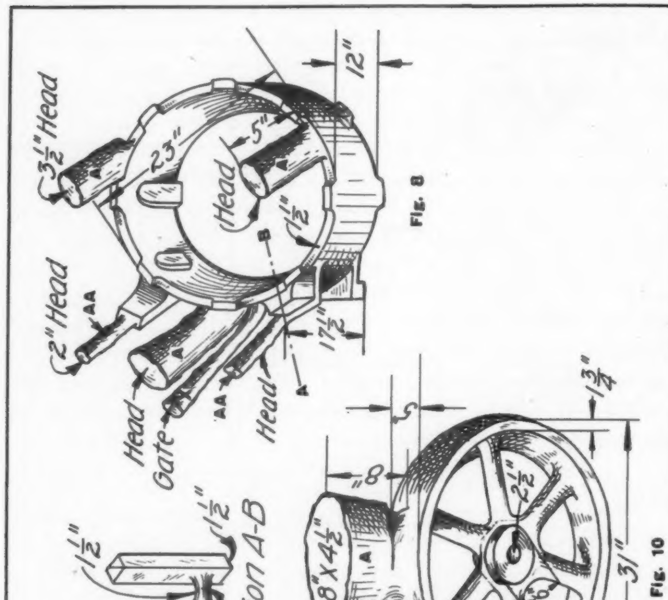
As in the previous test, the green sand bars are easily distinguished from the dry sand bars, showing greater solidity.

Only two bars can be considered to answer practical safe conditions. Bars A and E. No doubt bar A has an excessive head and can be reduced so that we might call bar E the proper standard for a head. In this bar the ratio of head to casting is as 20 cubic inches is to 32 cubic inches. There is 38 per cent steel in the head and 62 per cent in the casting. If we can accept the above test as an average standard, we are then able to compare our daily cast report against our daily shipments of castings, obtaining either good or bad returns according to the class of work produced. We must also consider the question of loss of steel in gates, which becomes excessive to the producer of small castings.

When the Molder is Turned Loose

Giving the ordinary steel molder a pattern with simple instructions to head and gate the casting, often leads to defective work. He may have a gate at hand which will answer, for the main point of importance is where the gate or its extremity, the sprue, attaches to the casting. This point can be properly sized and cut with the molder's tools, while the upper part must be large enough to admit the steel properly. It is often too large, resulting in considerable loss of metal. The head in many cases is peculiar to the pattern at hand and to obtain the best results ought to be cut and shaped before handing pattern to the molder.

In some foundries standard gates are prepared for every job that may come up. The heading, however, is left open to the molder. This method of procedure is not always practical, but when it can be followed the decrease in the percentage of bad or defective work will soon pay the expense of such a department. It is to the foundry what a tool-room or jig department is to the machine shop. There is no question but that an efficient molder can rapidly improve his knowledge of heading and gating by making it his special work, thus relieving the foreman of this important duty. This gives a



FIGS. 7, 8 AND 10—SKETCHES SHOWING DIFFERENT METHODS OF GATING

tone to the foundry system that goes a long way toward accuracy and the repetition of good results.

It is common in the steel foundry today when two out of 10 castings go bad, to say, "Well, John made all of those castings the same way," when if exact reproduction could be obtained, one would find the heads and gates to be located in as many different points as the casting surface would allow. There are few of us who never forget and this little weakness causes many defects in our steel castings which can be lessened considerably by some such method as I have outlined.

Our problem would be very simple indeed if all castings presented regular standard forms, but, as is well known, the engineer of today must build efficient machines, and this involves little consideration for the foundryman. It is his problem alone to produce solid, perfect castings from a network of confused shapes and sections run together, light to heavy and curved to straight, at any angle.

Many steel foundries have developed specialties, also methods of producing steel castings peculiar to their own requirements. In order that we might consider some well known standard forms, I have selected a number of patterns which will now be discussed. Also in order to be able to present to the society some other practice than that peculiar to my experience, I have requested a number of steel foundries to outline their methods of producing the same castings.

Gating a Simple Casting

The first of these castings is shown in Fig. 7. It is a cylindrical casting which is to be finished all over. The top under the head forms a cut pinion, the bottom plate of the casting being a friction surface for a brake. The form of the casting is simple, but as a perfect, solid job must be obtained, it is preferable to cast it on end with a large head on top. The gate or sprue must be run to the bottom of the mold so as to give clean steel in the finished job.

Two practical points must be observed in forming the mold. First, in cutting the sprue, keep the area of the cross section

at XX smaller than the cross section of the casting, otherwise when the gate freezes, it will pull a piece out of the casting at the joint. Secondly, the molder must be careful to remove the sand around the head before the casting sets, so as to avoid a check or crack in the main body. One way to avoid such losses, is to place a chill ring around the pattern at the point shown. This method will answer in some cases but not in all. The casting illustrated being heavy at the bottom, will require feeding, therefore, placing a chill at the middle would not allow the head to feed the bottom. This would leave shrinkage in the lower end. If the middle section of such casting is too light to feed the bottom, the foundryman must use his judgment in regard to using two large heads, one on each end. The replies to my letters of inquiry outlined two methods of casting on end as described. A third method, to cast flat with two heads, one on each end, also was suggested.

Gating a Circular Casting

Fig. 8 shows a standard form of circular shell casting, in the case at hand a magnet frame. Our experience has taught us to cast as illustrated, with three or four heads on the rim according to the section of the casting, and to gate between the feet with a bottom gate. The main points to be considered about such castings are first, to properly feed the heavy sections called pole pieces, and second, to gate so as to distribute the metal as evenly as possible around the circle. The poles, if concealed below the top section, will have to be chilled either by nailing or placing iron chills in the rear of the mold, held in place in the sand form.

The gate should be located as near the bottom as possible and so directed as not to cut or wash the inner surface of the core when entering the mold. Also, caution is necessary at the point of connection marked XX as outlined in the discussion of Fig. 7. Particular attention is necessary in all circular forms to relieve the casting of strains, by digging out the center core as soon as the metal is set. Some foundrymen pour water into the center of large cores to soften them at once. This is known as a water gate.

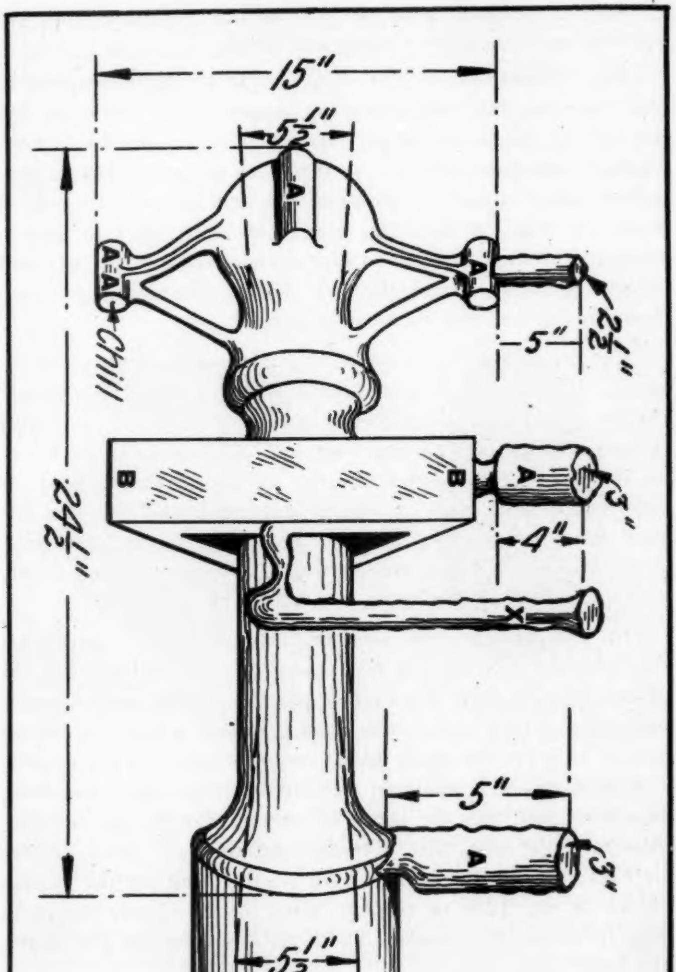


FIG. 9—A DIFFICULT STEEL CASTING TO GATE

Replies received from three foundries regarding this job agree as to methods of heading and gating.

Fig. 9 illustrates a light shell casting having extensions in the form of legs terminating in bosses. They must be fed so as to avoid shrinkage spots. It is possible, when casting such light sections, to omit the necessary heads, providing simply a gate or entrance for steel at one end and an outlet or relief at the other end. The main point in such a casting is to core it so as to give a clean casting and to avoid stresses when the metal shrinks. Three communications from foundries agreed with these suggestions.

Fig. 10 shows a gear blank, a casting common to all foundries. It must be clean and solid with no dirt or shrinkage. At the plant of the West Steel Casting Co. we have established a system of casting all gears on end, even as large as 4 feet in diameter. The sketch clearly illustrates the method of molding, which gives a clean, solid job. In the heading and gating of such a casting, cast on end, the shrinkage is troublesome and it is necessary to distribute the metal evenly so as to avoid all hot spots, causing checks.

In comparison with this method consider a gear cast flat with the four or five heads necessary to feed it. Fig. 11 shows such a casting from actual practice. What steel foundry can make a profit out of such waste of metal in heads or risers? It is a safe bet the heads weigh twice as much as the casting. Communications received by the writer from three foundries, however, gave two in favor of casting flat to one on end. Also consider the two different methods of gating shown in Figs. 12 and 13. The weight of the head on the casting shown in Fig. 12 is 66 pounds; those on the casting shown in Fig. 13 weigh 120 pounds. The latter has a bottom gate under the hub.

Fig. 14 shows a common form of lever or bracket casting, having a curved section with holding lugs. Such castings usually require caution in gating only so as to avoid checking when the metal shrinks. The heavier section or connection

must be chilled and the ends relieved with pop heads, or whistles, simply to allow the gases to escape quickly. My replies to inquiries were all in agreement.

Gating a Bull Pinion

Figs. 15 and 16 show two methods of casting common bull pinions. The method shown in Fig. 15 is preferable as it gives a clean casting when machined. It is easy to mold with a minimum of labor and weight of metal in the heads necessary to feed the casting solid. The method shown in Fig. 16

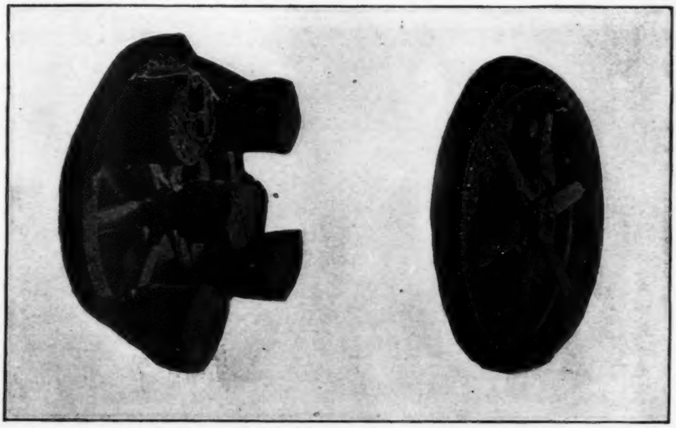


FIG. 11—WHEEL WITH SHRINK HEADS THAT ARE TOO HEAVY

not only requires more labor to form the casting, but requires greater skill to produce a clean casting when finished. My replies, however, gave two shops in favor of the method of Fig. 16 to one of Fig. 15.

Figs. 17 and 18 show two methods of heading and gating what is known as a double gear. This form of casting is very troublesome, as success in one part is at a sacrifice in the other. Our experience has taught us that we obtain the best results by the method shown in Fig. 17. This is the same as if we had two independent gears, each being provided with feeding and cleaning head. The method illustrated in Fig. 18 will always show shrinkage and dirt in some parts of the cut gears.

Also, the decrease of metal on heads is a deciding point to the foundry in favor of the method shown in Fig. 17. In answer to my inquiries, three replies were received and they all advised the method of Fig. 18.

A Troublesome Cross-Head

Fig. 19 represents a common form of casting having a bearing section connecting a ribbed or boxed section. The casting shown is a cross-head and a troublesome one to get solid at the base of the shoulder marked *BB*. If the section of *BB* is not large enough to feed the lower body, the foundryman must

FIG. 12 — A SATISFACTORY METHOD OF HEADING A WHEEL

FIG. 13—A WASTEFUL METHOD OF HEADING A WHEEL

not hesitate to notify the engineer of the necessary stock required to make a solid casting, and to mold accordingly. Some foundrymen place chills around the shoulder *BB*, but this practice does not allow the head to feed metal under the chill and therefore results possibly in a weak finished casting.

Figs. 20 and 21 present two methods of casting heavy bodies in molds so as to eliminate shrinkage as much as possible. This refers to dry sand molds where the castings are finished all over. Fig. 20 shows a casting setting on a chill. It is gated at the top, the metal falling on the chill. This method allows the hot metal to flow directly into the head, requiring

only a small amount of steel, possibly 20 per cent, to feed a solid casting. Fig. 21 shows a common method of molding such a casting, with a bottom gate and a large head on top. Steel foundrymen all know that to get a solid casting by such plain methods requires at least as much weight in the heads as in castings.

Fig. 22 illustrates a standard collar or sleeve used by many automobile builders. It is a troublesome little casting. The shoulder marked "chill" has no direct way of feeding the metal above and at each end, being too light in section to feed the inside section. It, therefore, becomes necessary for the steel foundryman to use his best knowledge, and set all the metal evenly by placing chills at the under section, as shown. Solid, perfect steel castings are often produced by pouring the metal slowly, being sure that enough steel passes through the mold and into the head, the casting setting and forming as the pouring finishes.

Fig. 23 illustrates one method of producing steel wheels. These may be gated either into the arms, ribs or hub.

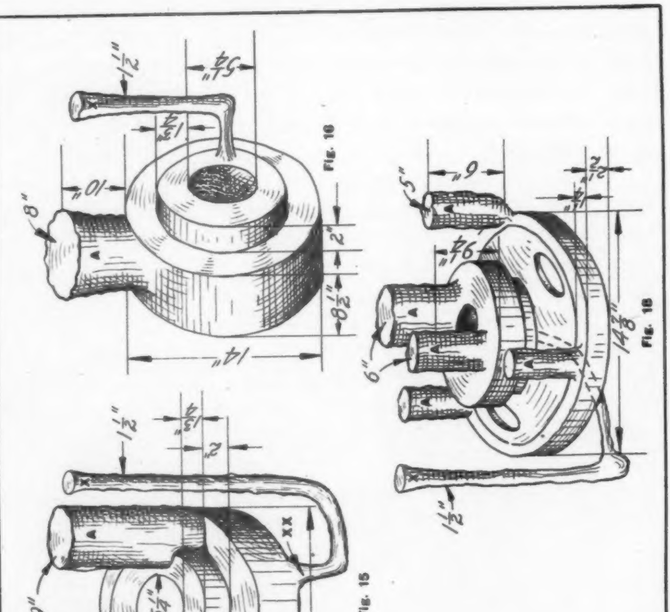
Stack Molding

Fig. 24 shows a method used in some foundries for molding and pouring small castings. It is called multiple or stack molding. The gate enters mold on the side, allowing the gases or riser to flow off opposite side. This system is troublesome, especially when only one gate is used, as the confined gases will not allow the steel to fill the bottom molds.

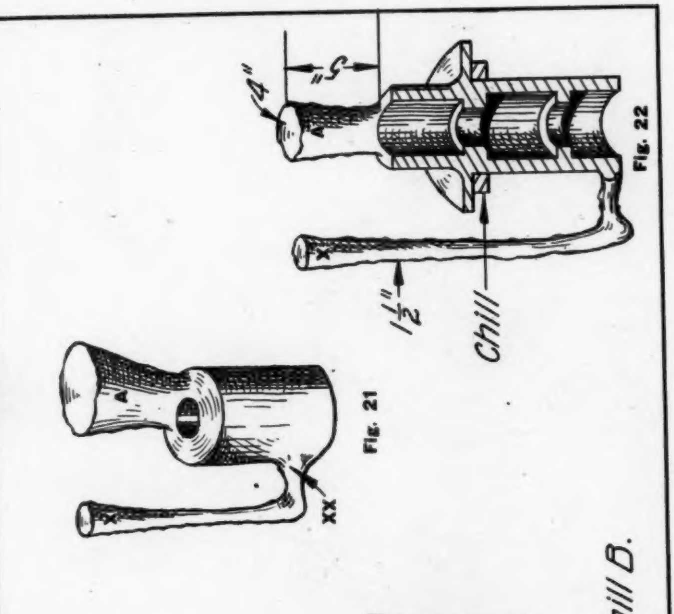
Fig. 25 shows a drum or method of casting a plain flange or circular ring. Two light heads on the rim and S-gate in the center are all that is required.

Fig. 26 represents what is known as a sheave wheel. The outer rims of such wheels are always of light construction with a heavy hub. Therefore, it becomes necessary to pour the molten steel rapidly into the mold, allowing full outlet for all gases formed. A bottom gate is provided on the hub.

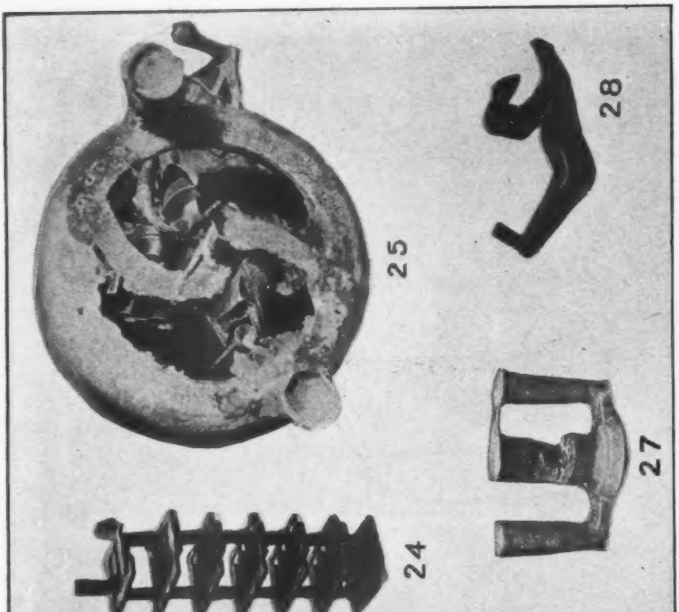
Fig. 27 shows a small bevel gear cast with two side heads and one top head. This is a troublesome small casting to handle and the side heads, while not accepted as efficient, answer the purpose at hand.



FIGS. 14, 15, 16, 17 AND 18—SKETCHES SHOWING DIFFERENT METHODS OF GATING



FIGS. 19, 20, 21 AND 22—SKETCHES SHOWING DIFFERENT METHODS OF GATING

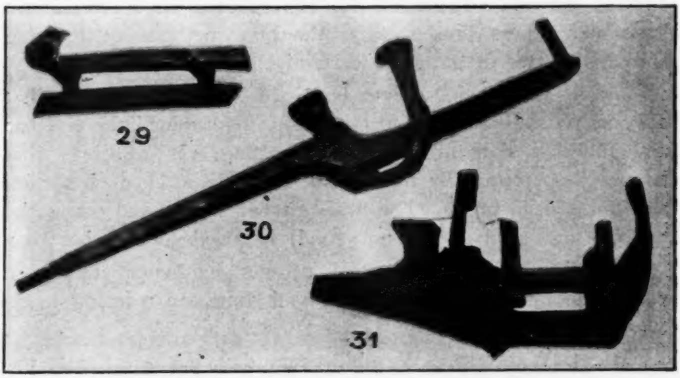


FIGS. 23, 24, 25, 26, 27 AND 28—STEEL CASTINGS PROPERLY GATED AND HEADED

Fig. 28 shows method of casting a small job, using a gate as a feeding head with a side riser connecting a heavy section.

Fig. 29 shows a method of molding and casting small plain jobs, readily mounted on boards for rapid production. Large sprues hold the castings together so as to feed them properly.

Fig. 30 represents a method of handling long, thin castings. It is very necessary in such work that all strain be removed at once from the casting. Therefore no gates or heads must be allowed to prevent the casting from shrinking.



FIGS. 29, 30 AND 31—STEEL CASTINGS PROPERLY GATED AND HEADED

Fig. 31 shows the amount of labor which must be expended on some jobs to produce solid castings, when they are made in jobbing shops. A head must be placed on every boss to insure a solid casting. The chill nails placed in the bottom bosses to assist solidity are clearly illustrated.

There are many more forms of castings which might be described but the foregoing will offer sufficient points for discussion. Today we steel foundrymen are more or less ignorant of our associates' practices. We must open up the gate in order to obtain more knowledge. This knowledge will lead us on to learn more, and through learning we can obtain some wisdom. Thus we may be able to develop a theory in relation to our practice.

Discussion—Theory and Practice in Gating and Heading Steel Castings

THE CHAIRMAN, W. A. JANSSEN.—Is there any discussion on this paper? Gentlemen, we have talked about metal, we have had papers presented on the best methods of molding and this matter of gating is certainly most important.

MR. J. WALTHER.—About test bars—I did some work that cost me possibly $35 to $40 to put up; I machined the test bar and found a flaw in it and the casting was rejected; that happened so frequently that I took a 6 x 12 x 1¼-inch section and put a head on it. The first test bar was sawed off at the bottom, and if that was not good, I sawed off another one.

MR. R. H. WEST.—Are any of you gentlemen chilling in your foundry practice? I understand some are refusing to do so.

MR. J. WALTHER.—We chill every day, but one has to use them carefully. The steel foundrymen are using ribs, but it is quite a job to remove the rib from the casting; so whenever I have a chance to use the chill, I do so.

The Use to which Malleable Iron Castings can be Applied in Car Construction

By Frank J. Lanahan, Pittsburgh.

One of the most important features entering into freight car construction (whether wooden or steel) is the character of the castings that are used to join individual sections together. These fastenings will have a material effect either in prolonging or abbreviating the life of such equipment. Malleable iron castings made by a reliable manufacturer who understands the proper production of such material, and knows the purpose for which it is to be used, will generally prove their superiority for two important reasons. *First,* it is believed they will give the longest service, and *second,* on account of their comparative lightness, will, for the same reason, prove the most economical. They are to be preferred to other classes of material sometimes used, for reasons which are enumerated in detail in the following pages, but briefly because of the fact that they are lighter and stronger than gray iron, smoother and less costly than steel, and compare favorably with forgings and are less expensive.

Gray Iron Used in Early Days

In the early history of the development of the car industry, gray iron castings were used almost exclusively, but as the railroads of the country expanded, equipment with greater capacity was necessary with the weight of the car reduced as much as was consistent with safety. With this change, gray iron was replaced by malleable iron, the sections of the castings were reduced, and the capacity of each car was very materially increased. Also its weight was reduced. However, there are some minor castings on a few railroads today that are made of gray iron, these applying practically only on old equipment. At one stage in the

development of rolling stock, the trucks were of the arch bar type, using column posts, etc.; the bolsters were equipped with center plates and on the underframe construction, such castings as bolster center fillers, center plate supports, striking plates, and the body castings were all made of malleable iron.

In the further development of the car industry, competition became very keen, and to decrease his costs, the car builder was obliged to reduce his weight per car. As he was unable to change the weight of standard rolled sections, this lightening process naturally fell upon the castings used in the construction. In many instances, the reduction in weight of the various malleable iron castings was not handled in a very judicious manner. For example, a striking plate would be designed with a 5/16-inch to ⅜-inch section of malleable iron, while ½-inch to ⅝-inch would be used in cast steel, and usually the ⅝-inch section prevailed.

It is at this point that the malleable iron foundryman made his big mistake by not objecting to the use of extremely light designs in service which demanded sections considerably heavier. This condition was probably due to the fallacy that existed at that time, that the strength of malleable iron rested mostly in the skin and that the function of the core was simply to act as a binder between the two surfaces. With such light designs as were put into service, the castings frequently broke and the failures were attributed to the malleable iron industry, when they should have been charged up to lack of knowledge upon the part of engineers in making such designs.

Later on, the heavy steel car that we are using today was produced. The engineer having in mind some of his experiences with extremely light castings that failed, owing to lack of knowledge of metals, changed many of the castings from malleable iron to steel. But when the engineer started to design for cast steel, he did not assume the responsibility as to the thickness of the casting that could be made successfully, as he did in the case of malleable iron. He took the matter up with the steel foundryman and ascertained from him what sections could best be made in cast

steel before making the patterns. This indeed was a very great advantage to the steel foundrymen in preventing an evil that had been borne by the malleable foundrymen for a long time.

It is pertinent to suggest that in the future when the drawing room is designing a new casting or redesigning an old one, if it will only take time and confer with the malleable iron foundryman in the same manner as it did with the steel foundryman, much better success can be obtained.

Merits of Malleable Iron

The resilience or resistance to shock of malleable iron is many times in excess of that in cast iron and for continued abuse in car service it is better than cast steel. This is because of the fine crystalline arrangement interspersed with temper carbon, which acts as a cushion and tends to break the path of fracture under shock resulting in simply driving the crystals closer together. The metal is quite ductile and will flow under shock, but is not subject to fatigue, crystallization or affected by extremely low temperatures in any marked degree.

The rust resisting properties of malleable iron are high on account of the carbon existing in a graphitic form, which tends to lubricate the crystals and as the structure is crystalline, the rust does not penetrate to any great depth but forms a thin oxide coating which acts as a protection to the inner metal. This feature makes it a very desirable metal for car construction where corrosion plays an important part in the deterioration of the metal parts. The coefficient of friction of malleable iron is less than of steel, making it a preferable metal for draft gear cylinders, etc. You do not get the abrasive friction which shortens the life, nor do the surfaces become glazed under constant frictional wear.

Quality Has Been Improved

Due to the combined efforts of the majority of the leading manufacturers of malleable iron castings to improve their product, they are today producing a casting far superior to that made a few years ago. The tensile strength and elongation has been increased materially, the tensile bars

averaging from 48,000 to 53,000 pounds per square inch, with an elongation of 10 to 12 per cent. They also have a high elastic limit. As this metal is freer from blow-holes than cast steel, the net section can be depended upon in designing, enabling the engineer to use a lower factor of safety. Because of the practice followed in malleable iron foundries, a much smoother casting can be produced which makes it more desirable to assemble, as a much closer fit can be obtained.

Attention will now be directed to some of the numerous parts entering into the construction of the modern type of car, wherein malleable iron could be used advantageously by the railroads. This statement is made with the realization that in the past mistakes have been made, but it should be remembered we have explained the cause of a great many of these failures. We will first take up the case of car trucks.

Car Trucks

The arch bar truck, a design that was standard on all railroads for many years up until the day when "specialties" arrived, has been replaced by many trucks having the cast steel side frame. In the construction of the arch bar truck, malleable iron column posts and spring seats were used. These trucks undoubtedly performed very efficient service and slanderous reports concerning their worst failures, when thoroughly investigated, proved purely fictitious. If the column post be correct in design, the railroad man need not be apprehensive as to failure of these parts in service, if made of good malleable iron, as tests conducted by some of the leading engineers of the country—recognized as competent authorities on the subject—have found, after exhaustive study, no appreciable stresses whatever in this member. Probably there may have been failures in the arch bars proper, due to inferior workmanship; this should have been corrected and not allowed to continue to the detriment of a most useful design.

The spring seats that fit into the channel spring plank can be made very successfully of malleable iron, using a 3/8-inch to 1/2-inch section, and are dependable. This de-

sign should be ribbed in such a manner as to permit practical molding, and it is then a compression member. It is considerably lighter than a gray iron casting.

The brake beam is one part of the truck that is depended upon for safe operation of the car. It should be designed, not so much for the minimum weight feature, but for the strength and service demanded of it during the life of the car. The most common error made by brake beam manufacturers has been to reduce the sections of the brake heads and struts, until they are 3/16-inch in many parts. Some manufacturers have changed their struts to forged steel and advertise this fact very extensively, stating its superiority over malleable iron. They formerly made the malleable iron strut in 3/16-inch and ¼-inch metal, while the forged steel strut is made of ½-inch metal, this being as thin as it can be made successfully.

If a brake beam is constructed with heads and struts of such thin metal, when new, it will withstand the M. C. B. test required. But the service demanded of the beam in the constant application of the brake produces vibratory stresses that tell in time, and if used in refrigerator or coal carrying service, where the corrosive elements are most active, the beam in time is naturally reduced somewhat. When later it fails, the cause should be attributed to the designer and not to the foundry, and the railroads should be acquainted with the full facts.

Brake connections, dead lever guides, live levers, etc., have been and are still being made very successfully of malleable iron. Owing to the location of these parts on the car, there is considerable deterioration but this is lessened by the use of malleable iron, and with the proper distribution of metal, these parts can be made light and sufficiently strong for the service required. The truck bolster, whether of the pressed, plate or trussed type, has a variety of castings. The dead lever fulcrums, which are used on every bolster, were made exclusively of malleable iron for many years. Recently some railroads changed to steel, and with the change of metal, the design was also made more rigid. Where it formerly consisted of a ⅜-inch flange riveted to

the bolster with two 3/4-inch rivets, it is now a 5/8-inch flange with three and sometimes four rivets 7/8-inch to 1 inch in diameter. Column slides and side bearings are still being made of malleable iron almost exclusively, except when cast steel bolsters are used. Truck center plates seem to have gone through a series of changes employing various metals and methods of manufacture, and while it is not necessary to enumerate them, it is well to suggest that if the railroad engineer will confer with the malleable iron manufacturer, he undoubtedly will be able to produce a design that will perform reliable service.

Underframe and Center Sill Construction

On the underframe and center sill construction there are a great many castings. The striking plate as well as the end sill on some types of cars has a very severe duty to perform. When certain designs of draft gear are used with a travel which will place the major part of the impact on the striking plate, the railroad man should then increase his striking plate in the proper proportion and the service rendered with the use of a malleable iron striking plate undoubtedly will be all that could be expected.

Center sill separators, bolster center fillers, center plate supports and various other castings used in center construction are being made of malleable iron. These castings all require close fitting and comparatively smooth surfaces, which are very readily obtained in a malleable iron foundry. It might be added that some designs are specified in malleable iron after the refusal of the steel foundries even to undertake to make the parts.

Relative to the draft gears, all of the leading manufacturers of this particular part of the car, who have an efficient device, use malleable iron. This unquestionably speaks well for the material.

Car Bodies

In the door mechanism of the various types of cars, such as hoppers, gondolas, general service, etc., malleable iron can be used for practically all details. The assembling of so many parts is readily accomplished and the operation of

the door is made easy, which combined with the service, makes malleable iron the ideal metal for these parts. The brake apparatus such as hand wheels, pawls, etc., on cars of all types is standard in malleable iron, while on box cars the post pockets and parts that join together various members including the car door fixtures have been made of malleable iron for years.

Conclusion

Malleable iron has been misunderstood and frequently criticised in the past, partly on account of incompetent and careless manufacture, but largely, too, because of the customer's insufficient knowledge concerning it. During the past few years, the industry has undergone a complete change, and the process and practice today is far in advance of the haphazard system followed three or more years ago. As an illustration, each foundryman formerly had his own analysis for the raw materials, and the same idea governed the finished castings. Neither analysis was based on any scientific knowledge, but simply what this or that individual thought was right. In contrast with such practice, the modern method is to follow a standard pig iron analysis, for a uniform result in the finished product, depending on the purpose for which castings are to be used. The standards so set, are the result of a long series of metallurgical, chemical, physical and other scientific tests.

From the foregoing information, customers can readily understand how necessary it is for a manufacturer to know exactly where the castings are to be used, and under what conditions, so that he may determine what particular feature should be developed as the casting's strongest characteristic. The malleable iron industry today is divided among specialists, each catering to the production of a definite class of material, such as railroad, automobile, agricultural, stove, pipe-fittings and miscellaneous lines, the main object being to perfect castings for the purposes intended through a careful study of the work they must do, as well as by concentration in one particular line, to effect economies through efficiency, and make the selling price as low as possible. In designing

castings, great care should be taken to have the section of metal sufficiently thick to perform the work required, otherwise failure will inevitably follow, not because of any imperfection in the iron itself, but owing to the fact that it is too thin.

Commendable solicitude on the part of engineers in their effort to obtain minimum sections, so as to reduce weight, and consequently cost, has in the past resulted in condemnation of the material, when the real trouble was caused by insufficient metal. In this respect, it is wise to follow good engineering practice, by figuring theoretically and designing practically, bearing in mind the extremely difficult service demanded at times, erring if at all, on the safe side, by having ample metal thickness to meet the requirements. The engineer knows when preparing a new casting just what is required of it, and if he would make it a practice to utilize the foundryman's experience and knowledge, so that in addition to the proper design, the correct section of metal is designated, to satisfactorily accomplish the task required, it would eliminate many of the pitfalls and troubles of the present day. Unwarranted criticism of the manufacturer, who is blamed for faults he is actually not responsible for, would disappear. Wisdom dictates the selection of a reliable and progressive malleable manufacturer, since this will insure conscientious attention to every detail of the casting process, and the customer will have confidence in knowing that he will get, in material, service and satisfaction, precisely what has been agreed upon, instead of a slipshod and imperfect substitute.

In conclusion, what most interests every buyer in any line, and more particularly with reference to castings, is what material will give the greatest satisfaction and service at the lowest final cost, and if prospective customers will make careful comparisons between steel, gray iron and malleable, they will find that on a dollar and cents basis, the latter, made by a firm that knows how, will far excel in value either of the others.

Discussion—The Use to which Malleable Iron Castings can be Applied in Car Construction

THE CHAIRMAN, J. P. PERO.—I want to compliment Mr. Lanahan on the strength of that paper and it is now open for discussion. We learn from discussions. A man gets up and reads a paper that expresses his views. He may not express yours, he may not express mine, but let us get our views mixed in with his, so that we may get the meat of the whole story.

MR. FRANK J. LANAHAN.—I take it that silence gives consent, and that the manufacturers of malleable iron here assembled agree with the statements made. Personally I wish to thank them for their co-operation in our efforts to make the malleable castings business a success where railroad castings are concerned.

THE CHAIRMAN.—I think you are right and that they could not pay you a bigger compliment than not to open their mouths, but to absorb just what you have said.

MR. C. H. GALE.—The paper presented by Mr. Lanahan calls for no discussion. As I see it, there is no opportunity for discussion. It is an excellent paper to present before a body of malleable iron men, but I think its proper place would have been to present it before a body of engineers. I think there is more good meat in that paper for our friends, the engineers, to absorb, than for malleable iron men. I shall make it my point to see that our construction engineers have a copy of this paper.

THE CHAIRMAN.—I want to say that all of these papers of course are to be published in the *Transactions* of the American Foundrymen's Association, and that volume is getting to be more and more each year a handbook for engineers.

because usually the textbooks represent the scientific or the theoretical side of the industry, while the *Transactions* of the American Foundrymen's Association represent the ideas of practical men, and for that reason each year these volumes are getting to be more and more used by engineers as giving the practical side of the industry and something that is reliable.

MR. S. G. FLAGG III.—I do not know whether this will be considered irrelevant at this particular time, but I think we have all been more or less impressed in the past with the publicity given to steel castings by the steel people, and this seems to me to be such a very valuable paper that I am wondering if we could not arrange to get this paper before other bodies of men, following along what Mr. Gale has said, so that we can bring malleable iron more to the front, explain more about it, and, if necessary, defend it. The steel castings people have had, I believe, a most wondrously organized campaign and they have done a lot for themselves and I imagine they are going to do a great deal more before they are through, and I am wondering, Mr. Chairman, whether we could not have some such method followed with a paper of this kind.

THE CHAIRMAN.—I think Mr. Flagg's suggestion is a very good one. Some time ago a few of us adopted a policy of getting a lot of these pamphlets, representing the views of different men in malleable iron practice, and sending them out on our own personal account to different engineers. This was done particularly by those who were interested in railroad car castings, and this thing could be done in the same manner in connection with this paper. Now, we can arrange to name a committee of two or three, if you wish, to take up that matter. I would like to get Mr. Lanahan's views on that, as he is the father of the paper.

MR. FRANK J. LANAHAN.—Personally I am perfectly satisfied with any arrangements that may be made by the members of this body. While the paper was prepared by me, it is nevertheless the paper of this association, having been prepared for it and delivered before it. I would be very glad, if the members think it of sufficient value, to have them take that

course. I call your attention to a few changes that I made in the paper as printed. You know the paper was written rather hurriedly and I only got the copy a day or so before coming to Cleveland. In reading, if you gentlemen followed me, you noticed in a number of cases where I changed the wording as it appeared in the printed copy. I think that we malleable men have gone along too many years hiding our light under a bushel, and, as Mr. Flagg has very properly said, the propaganda carried on by the steel men has had a very good effect, while we have gone along in the even tenor of our way, submitting to whatever calumnies were heaped upon our heads and not coming back to defend our position or the merits of our product in any way. I think the time is ripe for a definite understanding of what the malleable iron industry is, and it is pertinent, too, to bring out that, while we are having the engineers understand what malleable iron will do under proper conditions and to have our friends in the steel business realize that we are not altogether dead ones, that it behooves us all to be very careful concerning the product that we are turning out. You know it will not do to start defending our position if some of the errors of the past are going to be allowed to continue. We all recognize that fact very well. Every man must remember that he is one of the links in the malleable iron industry chain and that the strength of the whole is determined by that of the weakest link. That may be a little strong, but it is nevertheless true. If we do not all manufacture a high standard of product and retain the confidence that we should have, once we regain it, the malleable iron industry will be deader than ever. So I do think, Mr. Chairman, it would behoove you, as the chairman of this meeting as well as the president of the American Foundrymen's Association, to impress upon your co-workers the absolute necessity of close application to the work, hard study, and the production of material that is going to be a credit not alone to them, but to the industry as a whole.

The Chairman.—Mr. Lanahan has hit the nail on the head. His remarks are *apropos* and they are worthy of your serious consideration. As he says, the malleable industry

has received a black eye, but a great deal of the discoloration is gone, the eye is beginning to get a little more normal, but you have got to hold on to every inch you get. A little poor material will undo the work of several hundred times as much good material. I was going to suggest now, in connection with this or any other paper that is read at the session here today, that if individually you or the firms you represent want these papers to send out to your engineering friends and to your customers, without doubt you can secure them through Mr. Backert.

The Commercial Side of the Malleable Iron Industry

By W. G. Kranz, Cleveland

The malleable iron industry originated with the discovery in 1722, by Reamur, that carbon could be removed from cast iron by packing the latter in iron oxide and subjecting it to a high temperature for a considerable length of time. Reamur's discoveries were allowed to lapse and apparently were forgotten, as patents were granted to Lucas in 1804, and to Brown and Lennox in the middle of the last century for practically similar processes.

The first, however, to reduce the manufacture of malleable iron to practice on a commercial scale was Seth Boyden, of Newark, N. J. This was about 1820. Boyden was both a manufacturer and an experimenter, and successfully introduced his material into the engineering practice of his time. Boyden's process differed from that of the early experimenters in that the carbon in his material, instead of being removed, was converted into what was at that time designated by Ledebur as tempered carbon. This difference in results, even up to the present time, forms the basis on which the practices as carried out in Europe and America differ.

In Europe, the so-called white heart malleable is made by following the principles of Reamur's early discoveries, while in America, black heart iron is produced by the Boyden process.

Development and Growth of Demand

In the early days of the industry, malleable iron was used in place of cast iron and wrought iron forgings by many of the agricultural machinery and vehicle manufacturers. It had greater strength and more ductility than cast iron, and consequently the weight of the parts could be reduced. It was a metal that lent itself to being cast into very intricate shapes, and thus became a formidable competitor to forgings. Then,

in the early 80's it was extensively used in railroad car construction which created the real tonnage demand up to that time. The advent of the automobile in recent years gave the business another great impetus. The capacities of plants were increased and new ones built so that from 1900 to the present time the production of malleable iron has increased about five times. Statistics are not available, so there are no accurate records of this production. The foregoing statement is simply an estimate based on the malleable pig iron production, which in 1900 was 173,413 gross tons, and which reached its maximum in 1913 when 993,736 tons were produced.

It was not until the automobile industry sprang up a few years ago that the physical properties of malleable iron received very much consideration by the consumer. The automobile engineer appreciated the necessity for a material to withstand shocks and yet be easily machined, and found in malleable castings exactly what he wanted. It is gratifying to note that today a very large tonnage is going into that industry.

I will not attempt to go into a detailed discussion of the structure and physical properties of malleable iron, as these subjects have been so ably handled in papers before the association in recent years, but permit me to bring to your attention a few of the more common properties and uses of this product.

Erroneous Beliefs Corrected

Many people for some time held erroneous beliefs concerning this material. Some thought that malleable iron could only be successfully made in small sections; that its strength was wholly in its skin; that it was susceptible to crystallization under repeated shock, but all these theories have been entirely disproven by recent investigators.

In recent years many of our prominent manufacturers of malleable iron have carried on research or experimental work of considerable scope, aiming all the time to better a product they had been making for half a century. Great strides have been made due to these efforts, and today it is not uncommon to see malleable iron specimens with tensile strength over 50,000 pounds per square inch and elongations exceeding 15 per cent. On the other hand, a few unscrupulous manufac-

turers have sent out a product so poor that to a certain extent they have cast an odium over the whole field of malleable iron products.

As compared with a mild steel, we find that it has a higher elastic limit with possibly less tensile strength, that its ductility is even better, and that it is more dependable due to the fact that small test lugs may be cast successfully on the castings and after anneal, thoroughly tested.

It can be made in both light and heavy sections equally successfully. It is not susceptible to crystallization, and offers a great resistance to corrosion, the latter quality making it a material admirably suited for castings exposed to the elements. It has extremely good magnetic qualities, and on account of its permeability is forcing its way into various lines of electric apparatus.

Today we see a great tonnage of malleable iron going into railway car and track construction, the automobile, agricultural machinery, hardware and cutlery; and a smaller amount finding its way into other lines such as vehicles, stoves and electrical machinery. So looking into the future, it appears safe to predict that the more the engineer studies the structure and properties of this material, the more will the use of malleable iron be extended into other lines of engineering endeavor.

Discussion

Prof. Enrique Touceda.—I note that it is stated that malleable iron is now made which sometimes contains an elongation of 15 per cent. I said a few minutes ago that in the past 10 months I had made something like 8,000 or 9,000 different tests. Many of those bars have gone as high as 25 per cent elongation and 19 to 21 per cent is not uncommon. Those tests have disclosed that malleable iron is an exception to what holds true with all other metals, because I have found that as the ultimate strength increases the elongation increases also. Our experience is that as the ultimate

strength increases the elongation increases, which is something new.

THE CHAIRMAN, J. P. PERO.—Those of us who know Mr. Kranz can readily appreciate his making a conservative statement. He has been conservative in his figures of tensile strength of 50,000 pounds and an elongation of 15 per cent. That is a conservative statement now; a few years ago it would not have been, but it is today, and I think Mr. Kranz's idea was to be conservative. Few of us today are making iron that runs under 50,000 pounds. Once in a while we get a heat under this, but 50,000 pounds is not exceptionally high, nor is 15 per cent elongation.

A MEMBER.—I would like to ask Professor Touceda for the average tensile strengths of that series of bars?

PROF. ENRIQUE TOUCEDA.—I have the record in my pocket, but I have not got the data in the shape you ask for. This was made for a private report, and we have divided the bars into classes; the percentage that have gone under 40,000 pounds ultimate, those that have stood between 40,000 and 42,000, between 42,000 and 44,000, 44,000 and 46,000, 46,000 and 48,000, 48,000 and 50,000, 50,000 and 52,000, and above 52,000 pounds, so that they are not correlated in a way to give you that information. However, I can give you this information, to show you that the statement that I made is so, not from data derived from just a few tests, but from all these that I have told you about. I might explain the way in which these data were secured. If you classified the data according to ultimate strength, you could not classify it according to elongation, whereas if you took elongation as a classification you would meet the same difficulty with the other, so what we did was this: We classified it according to the data given you and then all of the elongations were taken and then summed up and divided by their number and that was considered to be the average for each class. The elongations ran this way: 4.3, 6.42, 7.24, 7.40, 9.33, 9.80, 10.54, 12.70. I want to point out one thing—that may seem to modify some of the things that I have stated, due to this record being the result of a great many tests from different plants where some are doing very well and some not as well, so that those that are not doing as well lower the general

average, but the average elongation on those bars that stood over 52,000 pounds was in this case in the first month that we started, 12.70, and in the last month it has gone to 15.80. That is, there has been an improvement between 12.70 and 15.80, and the month prior to that was 14.40. The law holds true for every month. For instance, the next, 5.53, 6.63, 7.51, 10.34, 9.31, 10.53, 12.02 and 14.06, and there has been no exception to the law that as the ultimate strength increases the elongation also increases, and that is an exception absolutely to all of the products I have ever seen, and I do not believe that these facts have previously been known. You will recall the specifications of the American Society for Testing Materials. Some on the committee were opposed to a high ultimate resistance because they feared lack of ductility and they said our stuff is for fittings, etc., and that they did not want strong stuff. So they made the specification based upon a lower elongation where greater strength was specified and they were willing to concede 7 per cent for an ultimate of 38,000 pounds. I do not remember just what the figures were, perhaps 6 per cent elongation, whereas if the specification called for 40,000 pounds ultimate they would agree to only 4 per cent elongation. You see the belief all along has been that in order to get high elongation you had to get low tensile strength. There is one exception in this whole list. In the last month, I am simply reading from a note I have placed here and I want to call attention to the fact that this is a private report, but I feel it proper to read it here, the average elongation for bars which stood over 50,000 has now reached the highest figure yet attained, 15.74, and that the percentage of bars that stood between 44,000 and 46,000 has now reached 92.51 per cent. That is of the bars of all of the members, including those who have not yet arrived to the highest point of excellence. The bars that stood over 45,000 pounds were 92.51 per cent, while those that stood between 46,000 and 48,000 were 81.06 per cent.

A MEMBER.—This gradual gain you have effected by changing the mixtures?

PROF. ENRIQUE TOUCEDA.—No, it has been accomplished by changes all along the line.

What is the Normal Fracture of Good Malleable Iron?

By Enrique Touceda, Albany, N. Y.

As the writer has often been asked to describe the appearance of the fracture of good malleable iron, he has thought that a few remarks on this subject might prove of interest. I have seen very few photographs of fractures that have been made with this object in view, and all that I have seen have either shown the fracture of a test lug that had been hammered off a casting, the fracture of a test piece, or of a casting that had been broken transversely. Such fractures are made complex by virtue of the fact that failure takes place due to the influence of both tension and compression stresses, these being of varying intensity depending upon their distance from the neutral axis. While it is a fact that failures in castings of any kind, in the majority of cases, are due to loads that produce bending, torsion or both, still I believe this subject can be more accurately approached by a study of fractures that have been produced through the sole action of a direct pull, as in making tension tests.

Lugs Are Broken Haphazardly

A test lug, for instance, is in the majority of cases broken in a very indifferent manner, and I have seen many instances where the first few blows were delivered so squarely upon the point of the lug that compression was about the only stress produced. As a matter of fact this is the common practice. The idea seems to be to hit the lug squarely on end, curling it up more and more by repeated blows until fracture takes place. The direct blows tend to compress and flatten out those crystals on the tension side of the lug as well as on its compression side and slip planes are not only produced but ductility may be practically destroyed.

It is evident that if a crystal of pure iron is compressed and flattened out, its subsequent ability to elongate when pulled is

greatly reduced. Consequently, when the lug is struck side blows in order to knock it off the casting, we will see numerous shiny particles on the tension side of the fracture, because, as already explained, the ductility of the crystals has been greatly lessened by the compression which they previously sustained and they will, when subjected to a pull, part through the slip bands instead of stretching. This leaves facets that will sparkle, so that the tension side of the fracture will have an abnormal appearance, be the material good, bad or indifferent, as compared with what the fracture of these respective grades would show if subjected to transverse or tensile stress only.

When malleable iron is broken transversely, the metal on one side of the neutral axis is of course in compression, and

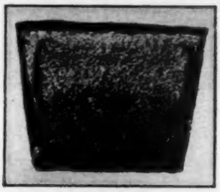


FIG. 1—FRACTURE OF MALLEABLE IRON BROKEN TRANSVERSELY

in any quality of malleable it will always appear silvery white at the extreme edge of the compression side, the whiteness being less in evidence as the neutral axis is approached, because, as stated, the compression stresses are of varying intensity, and the crystals farthest from the neutral axis are flattened much more than those nearer to it. Fractures that have been produced by transverse stress will always show a silvery white area on the compression side, starting faintly to one side of the neutral axis and growing deeper as the edge is approached, as is plainly illustrated in Fig. 1.

From the foregoing, it is clear that if we desire to ascertain the appearance of the fracture of malleable iron it is desirable to see what its fracture looks like when the metal in the entire section has been subjected to the same treatment as would be the case in a tension test. As you are doubtless aware, the

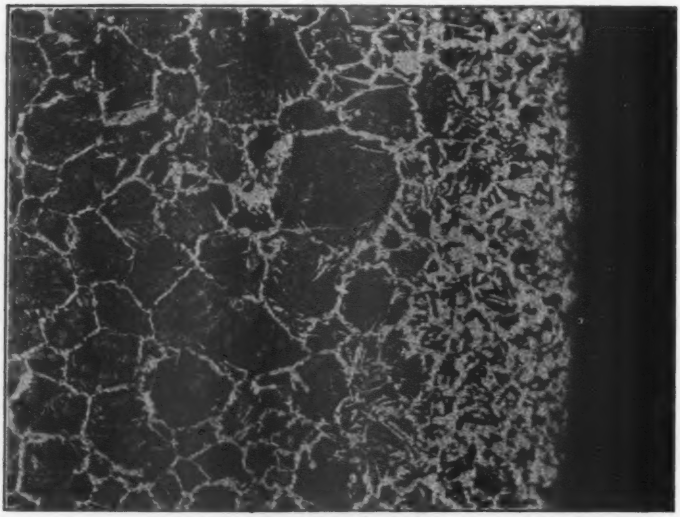


FIG. 2—SECTION OF A PIECE OF STEEL SHOWING DIFFERENCE BETWEEN SKIN AND CORE

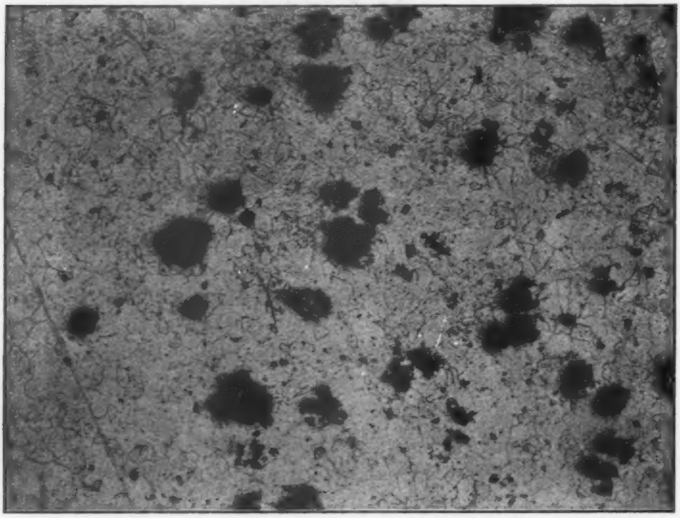


FIG. 3—STRUCTURE OF DECARBONIZED BORDER AND CORE OF ONE OF THE TENSILE TEST BARS ILLUSTRATED IN FIG. 4

structural composition of malleable iron consists simply of two constituents, including about 98 per cent, by weight, of ductile iron practically free from carbon, and about 2 per cent of small rounded particles of graphitic carbon uniformly distributed throughout this mass of iron, except within the decarbonized border.

Carbon Burned Out of the Surface

It is a well known fact that it is not possible to heat a steel casting, a steel billet, or a malleable iron casting in the oxidizing gases of a furnace without removing a great deal, if not all, of the carbon from the metal for a certain depth under its surface. In commercial practice this depth will vary anywhere from a 1-32-inch to a 1-16-inch. As steel contains no graphitic carbon the fracture of a broken piece will be uniform in appearance throughout, and the characteristics of the fracture can best be described by the accepted term "Steely". The microscope, however, will disclose the fact that there is very much less carbon in the nearly decarbonized ring of metal referred to, than in the core which it encircles. The reason, that when the fracture is examined by eye, the border is similar in appearance to the core in the case of steel is due solely to the fact that the appearance of the steel fracture does not depend upon carbon percentage, unless the amount of carbon between the steels that are being compared varies greatly. For instance, the fracture of a 0.10 per cent carbon steel would look about the same as one that contained 0.40 per cent carbon. A polished and etched section however, when viewed under the microscope shows that a great difference exists between the two, which can be plainly seen by reference to Fig. 2, enlarged 60 diameters. This illustration shows the difference in structural composition between the skin and core of a piece of steel that was ⅝-inch thick.

Even in the case of the very best malleable iron the eye easily distinguishes the difference in appearance between the decarbonized border and the metal it surrounds, because the former is practically carbonless and looks steely, while the latter is dotted with numerous particles of graphitic carbon causing the metal to look dark. Consequently, due to contrast, the border is plainly visible.

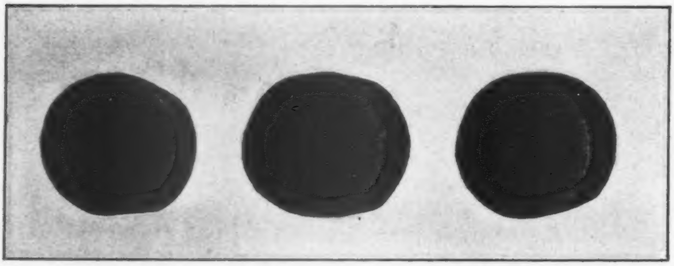


FIG. 4—FRACTURE OF TENSILE TEST BARS HELD PERPENDICULAR TO AXIS OF LENS

In Fig. 3, which is enlarged 60 diameters can be seen both the structure of the decarbonized border and the core, as it is misleadingly called, of a section taken from one of the tensile test bars shown in Fig. 4. The skin, as you will note, is practically free from carbon, while the little particles of graphitic carbon can plainly be seen distributed with great uniformity throughout the iron of the core. You are aware that any commercial iron product containing but little combined carbon must of necessity be ductile, and as good malleable iron contains but little, if any, it must be ductile material.

An Erroneous Opinion

If I have dwelt upon this matter somewhat at length it is because there appears to be an erroneous opinion, first, in connection with the characteristics of the border or skin

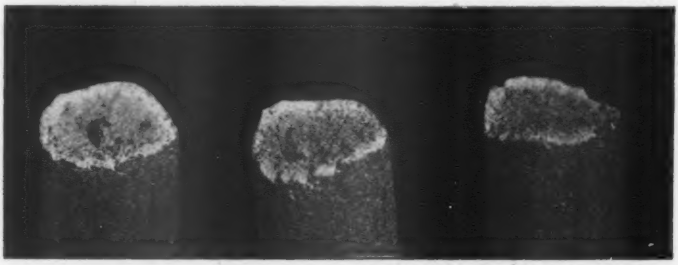


FIG. 5—FRACTURE OF SAME BARS AS THOSE SHOWN IN FIG. 4, HELD OBLIQUE TO THE AXIS OF THE LENS

of malleable iron, second, because of the common belief that a decarbonized border or skin is unique in malleable iron and not present in steel, owing to its invisibility in the fracture, third, because the skin must be taken into account in considering the fracture of malleable iron, and fourth, because this socalled skin can in the case of inferior malleable iron be of itself an explanation of its inferiority.

In Fig. 4 is shown the fracture of three tensile test bars. The bars have been held in such a position that the fractures were perpendicular to the axis of the lens; while in Fig. 5 another view of these same fractures can be seen.

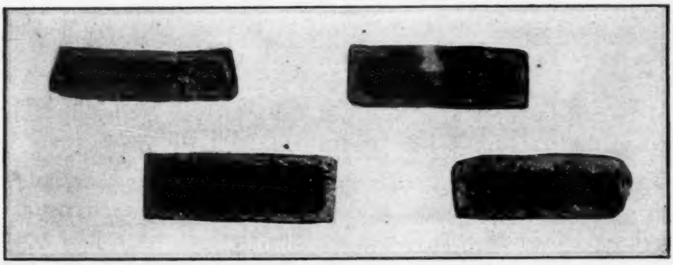


FIG. 6—FRACTURE OF BLACK HEART MALLEABLE

In the latter illustration the plane of the fractures was held oblique to the axis of the lens.

These two views were taken for the purpose of illustrating the appearance of the fracture of good malleable iron when broken by direct tension and when held at different angles to the direction of the light. When this material fails due to a steady, direct pull, the crystalline grains of iron, when the elastic limit has been reached, start to elongate permanently. As the test proceeds, they stretch further and become thinner, and just prior to fracture they become tapered down to a point.

The fracture then has what is known as a "tooth", because its surface is made up of an innumerable number of spines that have resulted from the elongation of the numerous grains in the metal. In Fig. 4, that part of the

fracture encircled by the decarbonized ring appears to be of a dark gray color. This is due in part to the presence of small particles of graphitic carbon and in part to the shadows that are cast by the spines of the elongated grains. The skin, or border, looks white, due in part to the fact that no graphitic carbon is present and in part to light reflection. When the bar fails, the metal in the border being slightly more ductile, breaks last and at an angle, and consequently, when the light shines directly on the fracture of the core, it shines obliquely on the surface of the border. If however, the bar is held obliquely to the direction of the light, as shown in Fig. 5 a very fine silky sheen will be seen that varies in shade from a silvery gray to darker shades of the same color, as the obliquity of the fracture to the light is decreased. Such will always be the appearance of the fracture of a tensile test bar of good malleable iron when the fracture is held in the various positions described.

If a bar is broken transversely, then the part that failed in tension should show, in a large measure, the characteristics covered by the foregoing description, while the part that was in compression would have the whitish looking area already referred to, and the more ductile the metal the greater will be the depth of this area.

Only a few years ago such fractures as are shown in Fig. 6 were considered typical of what the fracture of good malleable iron should be, and it is actually due to such fractures that malleable iron made in this country received the name "black heart". Such iron as this is defective, as the border instead of being decarbonized, contains considerable carbon in the combined form. As a matter of fact it is a steel, and consequently is more brittle than the core. When good malleable breaks in tension the core parts first, as must be the case if its ductility is slightly less than the metal in the skin. This fact alone is sufficient to prove that those who have claimed that the strength of malleable iron lies mostly in the skin are misled. In the case of material whose fracture is similar to that shown in Fig. 6, the skin breaks first as it is more brittle than the core.

Discussion—What is the Normal Fracture of Good Malleable Iron?

Prof. Enrique Touceda.—This subject was selected for several reasons. It was written partly for the engineer, partly for the inspector and partly for yourselves. I have noticed, in visiting different manufacturing plants, that the department which is educated to the highest point of efficiency is the sales department. Take, for example, a stove works. You will find that they have a large show room in which all of the stoves of their competitors are placed alongside of their own stoves, and their salesmen are educated to see the defects in their competitors' stoves and the merits of their own, so that in selling stoves or any commodity of that kind the salesmen have right at their fingers' ends the reasons for this, that and the other thing, and they answer very promptly any question that is asked. The malleable man has given but little if any thought to that subject. For instance, the salesman goes to the purchasing agent, who says: "All the merit in a malleable casting lies in the skin," or "Malleable iron has a skin and the balance of the section is not strong", and it is this, that or the other statement, with the result that at the instant he has not got the answer right at his fingers' ends. So I think it would be well for the malleable man to be so well posted in regard to the different statements that may be made that he has the answers at his fingers' ends also, just like the salesmen for the stove works, in order that should a question be brought up that is detrimental to malleable iron or something is stated under a misconception of the true facts, he will have his answer ready and right. I have noticed shortcomings referred to in many instances.

If a man be written to he has the time to think things over and he will probably give you the correct reason, but if

asked a question the answer should be instantaneous; he should be equipped to know the reason and to know it right away, and it was with that object that this paper was written.

There seems to be a good deal of misconception in regard to what the true fracture of good malleable iron is. I will not attempt to read my paper through. I do not think that this is necessary; but the point I wish to bring out is this: First, that steel has a skin just as well as malleable iron, so that if that argument is advanced as in any way being detrimental to malleable iron you can say that in that particular steel does differ from malleable iron because it has a decarbonized skin just as well as malleable iron. The rate of decarbonization is not so great as in the case of malleable iron, because malleable iron is heated for a greater number of hours, but it has one, as you can see from the micrographs which form a deadly parallel, Figs. 2 and 4. You can easily see the decarbonized skin of the steel casting and you can see the decarbonized skin of the malleable iron in the other micrograph. If such a question is asked I think that this is one of the points that should be made plain to offset what the steel man says.

In regard to certain characteristics when the fracture of the malleable iron is broken transversely, you have seen a man break a test lug off of a casting, and in order to make a good showing he hits it right on the end. If your material is poor, it is not a bad thing to do. At the same time, if your material is good, it is going to alter the appearance of the fracture, because when you hit such a blow you produce compression and that flattens out the crystals, so that when fracture takes place you do not get a normal fracture. You get bright specks throughout the fracture, which are objected to by the inspector, and it is just as well that you know and understand what produced them, and the inspector should be told that you cannot break a test lug off of a casting without in some measure producing that effect, because a part of it on one side of the neutral axis must show, to a greater or less extent, that appearance.

The inspector takes exception frequently to a kind of a dove-colored appearance of the skin of very excellent malleable iron. This color is due entirely to light reflection. That is,

if you take a piece of malleable iron and break it, the little crystals elongate in the same manner as if you took a chunk of taffy and pulled it apart; that is, they elongate into spines. If you hold the section to the rays of light you will see a sheen, due to this light reflection. In the very best malleable iron I have seen you can note this appearance. If you observe closely you will note that there will always be two rings outside of a central core. Instead of there being one ring for a border, as is commonly supposed, there are nearly always two, and one is a little darker gray than the other, and in very well-annealed, strong malleable iron, you will see this very markedly, and you will see a lighter border on the outside, and then this different colored border within it and then the core. Now, exception is sometimes taken to this by the inspector, even in good malleable iron. The appearance is due to a very peculiar thing which occurs and which I will not enter into here, but the decarbonization seems to take place in steps. The outer ring is nearly entirely decarbonized, though there may be a few little specks of carbon distributed through it, while the next ring is decarbonized, but not to the extent of the outside one, and in this ring the little nodules of carbon will be much smaller than in the core, in which the nodules are much larger and more abundant. The depth of the rings is ⅝-inch, bars will often be 3/32-inch, and some times deeper. This is certainly not defective malleable. It is the best malleable that you can make, and the explanation of these colors is that they are due to light reflection. I thought that if you had a paper of this kind available, that is, some data on hand when these questions were brought up, that a ready response could be made to the man who was taking exception to these characteristics. In the last part of the paper you will notice fracture characteristics of what is really defective malleable iron. I have seen quite a number of papers written and also books in which this character of malleable iron was given as of the best quality. It really is very defective. The skin shown is not decarbonized, though it looks as if it were more decarbonized than the other. In this case the carbon exists in the combined form and the white border or frame is really a steel. It has been partly decarbonized, but the

character of the carbon is not such as should be present in normal malleable iron. In the case of a tensile test bar of normal malleable iron the core will break first, which is a thing that is well to remember, because many engineers believe that the strength of malleable iron lies in the skin. If the core breaks first, it obviously cannot lie in the skin. You will agree with me very readily if you will think of this experiment, which, while rather far-fetched, will, I think, explain the matter. Suppose you had encased around a bar of malleable iron a rubber tube that was tightly fitted to the malleable iron bar. Let us assume that you pull it in a testing machine. It is manifest that the bar would break and the rubber would stretch but would not break. This is absolutely a parallel case to what happens with the skin and core of good malleable iron, but in the case of poor malleable, the kind from which "black heart" has derived its name, the skin breaks first and there is then an invitation for the core to follow suit. The skin is so brittle and lacking in ductility that it breaks first and shortly afterwards the core, but in good malleable iron it is the core that breaks first, and if you will endeavor to keep these different points in mind when the question of skin is brought up against the material and have the right answer at hand, I think it will be of benefit to the industry.

The Chairman, J. P. Pero.—As usual, when Professor Touceda talks about malleable iron he says something. I am sure that he will be glad to answer any questions in connection with the paper that you may see fit to ask.

Mr. S. G. Flagg III.—I would like to ask Professor Touceda if in the photograph shown in Fig. 6, having heavy crystalline ring around as shown, whether those are the ones that he says are not good malleable.

Prof. Enrique Touceda.—Yes.

Mr. S. G. Flagg III.—Can you tell us, without going too deeply into the subject, whether that is a product of over-annealing or is attributable to the mixture of the iron?

Prof. Enrique Touceda.—That is due entirely to the mixture, not to the annealing. No matter how well you anneal such iron, you will obtain a frosty white frame and get that

character of core. It is the result of a defective mixture, but you can produce it in many different ways. That is, you can produce it by high silicon or low silicon and there are certain ratios of the elements you have to attain in order to produce it, but you can identify each variety by the appearance and the color of the skin and determine the cause that produced it. That is, each case has a different appearance, one that could be very readily shown to anybody. They might have a little difficulty in picking it out simply due to the fact that they have not seen enough samples to form a correct opinion, but I think that we have finally reached a stage where we can tell very closely exactly the conditions that cause these characteristics by the appearance. For instance, one appearance is called *sugary*. In one case this border is very flaky and I have adopted the name *sugary* to express this character of the fracture. In others it is very fine and we call that *porcelainic*. In some it is very white and in others it is a little darker. You have to have a typical sample as a standard at the start to compare with, just as you would take two diamonds, for instance, where one looks perfectly white and you would say it is the whitest one you ever saw until you had a standard to compare it by and then you would see that it was very dark as compared with that standard.

Mr. P. H. Davis.—I want to ask the Professor how he reconciles the statement that he makes that in a good malleable casting the core breaks first with the statement that he makes that in removing the outer part of a good malleable casting you do not remove the best part of the casting?

Prof. Enrique Touceda.—I did not understand the last part, Mr. Davis. I understood the first part of the question, but not the last.

Mr. P. H. Davis.—I want to know if you remove the outer part of a good malleable casting whether you do not remove the best part of it?

Prof. Enrique Touceda.—In a sound malleable casting I do not believe you do, except in this way, that the size of the crystal depends upon the rate of cooling, and the size of the crystal may be a little smaller and more dense on the skin than in the center,

but I believe that the tests which have been published to show that the core of malleable iron is worthless were in most instances due to the fact that the bars that they experimented with were not sound. I have had charge of the testing of something like 7,000 or 8,000 bars within the last 10 months, and our greatest trouble at the start was in getting sound bars. It is a very difficult matter to get a sound test bar, and we found that a great many bars, at the start of our experimental work, broke in the grips where the section was the largest. If a bar is going to break where the section is the largest, it shows that the bar is defective, because no bar will break where the section is the largest, normally. This is always due to unsoundness. In years past, when those statements were made, I think those who carried on the experiments were not careful in getting sound bars. I believe that the best material in the bar, as a whole, is always in the skin when the malleable iron is bad. I do not believe that is true when the malleable iron is of high grade and quality.

Mr. P. H. Davis.—I think you hit the point I am trying to get at. I think the statement you make proves the contention of the other man when he says that the best part of a well annealed casting is on the outside; the elongation of the outer skin is greater than the core which breaks first.

Prof. Enrique Touceda.—Doesn't that prove that the skin breaks last?

Mr. P. H. Davis.—The skin breaks last because the elongation is greater.

Prof. Enrique Touceda.—Then I think you have proved my contention, Mr. Davis.

Mr. P. H. Davis.—No sir, I take issue with you on that.

Prof. Enrique Touceda.—It may be that I cannot reason that out to your satisfaction, but it is manifest that if the elongation is greater in the skin than in the core the core must have parted first.

Mr. P. H. Davis.—If the elongation is greater on the skin than on the core the very fact that the skin has a greater elongation than the core proves that it breaks last. You say that

it breaks last. If it breaks last, the elongation is greater on the skin than it is in the center on the core.

Prof. Enrique Touceda.—Mr. Davis, I have just one question to ask you. Let us take the case of a rubber tube—

Mr. P. H. Davis.—We are speaking now of malleable castings. You cut through a bar. You examine it with the naked eye, and you see that is in the form of a laminated structure, showing the decarbonization as it penetrates that casting. Any of these gentlemen will bear me out on that if they have ever examined these things.

Prof. Enrique Touceda.—Let us take the case I spoke of where you have a rubber casing around a malleable iron bar. It is evident that the malleable iron bar is going to break first.

Mr. P. H. Davis.—Yes.

Prof. Enrique Touceda.—Now, your rubber has not yet broken. Let us assume that you operate the machine to a point where you break the rubber. Is the rubber stronger?

Mr. P. H. Davis.—Why hasn't it broken? Because it is elongated.

Prof. Enrique Touceda.—That bears out my statement.

Mr. P. H. Davis.—That is what we are trying to make. We are trying to make a malleable casting. A malleable casting is a pliable one, a soft one that will bend.

Prof. Enrique Touceda.—You have not answered my question, Mr. Davis. I have given you the parallel.

Mr. P. H. Davis.—In the matter of the elongation of the rubber tube, there can be no argument on that, because we all know that that elongates more than the core of the malleable casting that is on the inside.

Prof. Enrique Touceda.—You have acknowledge that the skin elongates more than the core.

Mr. P. H. Davis.—The admission on your part that it does elongate proves my theory that the outer shell of the casting elongates most before breaking.

Prof. Enrique Touceda.—Elongation is not strength, you know.

Mr. P. H. Davis.—You are speaking of elongation. You are wrong, Professor.

Prof. Enrique Touceda.—If that will satisfy you, Mr. Davis, I will say I am.

Mr. P. H. Davis.—Let us get it right to start with. Instead of speaking of malleable iron let us call them malleable castings. That is what they are. We are talking about malleable cast iron, not malleable iron castings.

Prof. Enrique Touceda.—Speaking of the rubber again, I have seen some manufacturers who make malleable castings that had to be hit with a rubber hammer or one would break them.

Mr. P. H. Davis.—I will say to these gentlemen here that I have been engaged in the malleable business for something like 43 years. It has been that long ago since I first started in the malleable works.

The Chairman.—I do not think we are quite clear on the discussion between Mr. Davis and the Professor. I think each of you are talking about two different things. One was talking about strength and the other about elongation and I think each is right in his own way.

Mr. C. H. Gale.—I would like to ask the Professor about the decarbonized rim spoken of in steel. That refers particularly to an annealed piece of steel, does it not?

Prof. Enrique Touceda.—That is the general case, I am sure.

Mr. C. H. Gale.—Speaking of cast steel?

Prof. Enrique Touceda.—I am referring to rolled steel as well as cast steel. That was a piece of forged steel that came from a shell, a piece of shell that was heated for forging. The remark holds true of any steel at all, whether it is rolled, forged, annealed, or not, because you cannot heat a piece of steel to redness without decarbonizing the skin. If you want to make a milling cutter out of a piece of crucible steel and you want that milling cutter to be four inches in diameter you have got to order a piece of steel that is four and a half so as to take off a quarter of an inch. Otherwise the edges of your teeth will be no good because they have not got sufficient carbon.

Mr. C. H. Gale.—Take a piece of cast steel, wouldn't that decarbonized rim be more marked if it were annealed than not annealed?

Prof. Enrique Touceda.—I will make one exception to what I stated. A piece of cast steel that has not been annealed is not worth anything because it has a crystallization that depends upon the temperature at which it has cooled, and of course it has cooled from a very high temperature. If you used a casting of that kind it would not be dependable at all. You have got to anneal a steel casting in order to get one that is worth anything. I will make an exception in this case, but I did not speak of that for the simple reason that you have not got a marketable product in this case, if structural material be considered. It might be used in very small work or something of that kind, but we are speaking now of castings for agricultural implement work, railroad or automobile work. You never saw a steel casting where dependability was required made by any one who knows how to make castings that were not annealed.

The 25-Ton Air Furnace

By F. C. Rutz, Rockford, Ill.

The malleable furnace has perhaps escaped being written about as much as any one subject pertaining to the malleable industry, and yet it is one of the most important. Improperly constructed or improperly handled furnaces are apt to wreck the best chemically calculated heat. Simple measurements of the openings between the top of either front or back bridge and the bottom of the bungs over them, are apt to make either for melting with just the proper oxidizing flame, or slow melting. The latter gives the flame too much play on a slow trickling of metal causing the familiar "high heat", or too low a silicon content.

Metal Should be Snappy and Fluid

A properly handled furnace will cause the metal to collapse quickly into a molten state, giving the desirable snappy life and fluidity, with a consequent decrease in defective castings.

In my opinion, after having had experience with various sizes of furnaces, the 25-ton furnace has a sufficient number of points in its favor to warrant its adoption. These points include (1) decreased operating expense, (2) flexibility, and (3) space economy.

Let us first consider decreased operating expense. From cost figures available, the larger furnace can be operated at a total cost of $3.25 per ton, including firemen, coal, ash, slag and repair labor, all materials, tools and equipment. This figure is an average cost for the past four years, based on average heats of slightly over 18 tons. The charges are proportioned as follows:

	Per Ton
Firemen, labor	$0.25
All other labor	.40
Coal	2.00
Brick	.38
Fire sand and clay	.05
Tools and equipment	.16
Motor and fan repairs	.01
Total	$3.25

From figures available, obtained from a number of sources, covering costs on 12 to 15-ton furnaces, the cost of melting per ton averages approximately $3.85. Owing, however, to different methods of distributing costs, a satisfactory comparison cannot be arrived at, itemized as above. The final result, however, seems to be greatly in favor of the larger furnace.

Melting Ratio is 2.75 to 1

Regarding the melting ratio, a fair average covering a year's tonnage, actually poured, would be 2.75 to 1, after allowing approximately 13 per cent for shrinkage on the total amount charged, owing to oxidation, slag, etc.

Taking up the question of flexibility, the advantage also appears to be greatly in favor of the larger furnace, owing to its adaptability for either large or small loads, depending upon the grade of work that one desires to make. Small heats of 12 to 15 tons can be handled as successfully as 20 to 25 tons, merely by keeping the bath of the metal at the proper depth. Another valuable feature of the larger furnace is the great space economy that can be effected, owing to its ability to do practically double the work of the 12 to 15-ton furnaces. The saving of floor space may be turned into productive channels.

Dimensions of Furnace

In conclusion, let me present just a word regarding the detailed dimension figures of a successful 25-ton furnace. The grate surface is 5 x 8 feet. The grate bars are 6 inches wide, with ⅝-inch openings. The opening from the top of the front bridge to the bottom of the center of bung is 27 inches. The back bridge opening is 12½ to 13 inches. The lower blast pipe is 17 inches in diameter. The top blast is 6 inches in diameter. From it eight pipes having 2⅛-inch openings, pitched so as to strike at the base of the front bridge wall, extend through the wind bung. The height of the front bridge from the top of the grates is 40 to 42 inches. The blast pressure is 5 ounces. The above dimensions have proved the most successful among a number of experiments made to get the most economical results.

Discussion—The 25-Ton Air Furnace

THE CHAIRMAN, J. P. PERO.—I am sorry Mr. Rutz is not here to speak, because I think that among the greater number of malleable casting foundries today the furnace is usually less than of 25 tons capacity, and we do know that there are some 25-ton and even larger furnaces in use and have been used for years by some people, and they are very strongly in favor of them. On the other hand, we know of some of those larger furnaces that have been dismantled and smaller ones have replaced them. There are one or two little points that attracted my attention in this paper. One is as to the economy of space that the writer lays stress upon. I do not mean to take unfair advantage of the absence of the writer, but I just want to call attention to this, that it seems to me that the advantage of economy of space would be more than offset by smaller furnaces from the fact that there would be a less distance to carry the iron, and it seems to me that is a big factor. There would also be the consideration of the fatigue you would have to impose upon your men or the labor cost of carrying your iron, and the loss in your iron due to the iron cooling before it got to the farthermost end of the shop. I want it fully understood that I am not criticizing the paper in the writer's absence. I just wanted to bring out those points. I know that we have men here who have had experience with the larger type of furnaces as well as on the smaller ones and I think it would be interesting to hear from them.

MR. S. G. FLAGG III.—We have operated 25, 26 and 27-ton furnaces and the objections that you speak of regarding the distance the iron has to be carried are not very serious, if you are accustomed to the type of furnace. I think we all have a fairly large selection of casting work that we can regulate. In our general practice we have been successful in putting our heavy work farthest away from the furnace and in that way

we have had an advantage which is not inconsiderable in reducing the temperature of the iron and consequently reducing shrinkage. That has helped a great deal in reducing losses on big work. The smaller work can be placed nearer the furnace and you get hotter iron. Of course, it does take more floor space than a smaller furnace, but I think perhaps it is more a matter of what you are used to in your shop than it is a matter of real economy, although I think on big heats it is perfectly possible to get, as Mr. Rutz says, 2.75 or three to one as a coal and melting ratio. I know of some people who use a small furnace and take two heats from it, and of course they have the advantage in the second heat of starting to melt with a hot furnace, which is an advantage. I can only say that the statements contained in this paper—while I cannot check up with any accuracy the cost statements—I can check up the fuel ratio, which I think is about what is generally obtained from those heats. Of course, you should have tap holes on all of the levels, two levels or perhaps three, so that you can tap off first from the higher tap hole.

Mr. R. F. Harrington.—I would like to ask Mr. Flagg if those 25 and 27-ton furnaces are operated every day.

Mr. S. G. Flagg III.—They are; six heats a week.

Mr. R. F. Harrington.—That is, with natural draft?

Mr. S. G. Flagg III.—No, forced draft.

Mr. R. F. Harrington.—What is the time required on the 25 to 27-ton furnace?

Mr. S. G. Flagg III.—That depends upon your coal. If you have got good, big coal, you ought to melt down at the rate of 3 tons an hour. As a matter of fact, that has been done with fine coal. We have melted at 2 tons an hour, but by picking the coal, one can melt 3 tons an hour.

Fred Van O'Linda.—There does not seem to be any uniformity as to the manner of heating furnaces before charging. Some people believe in heating their furnaces one or two hours before they charge. Others charge on a perfectly cold furnace. I would like to hear some discussion along that line.

The Chairman.—I was glad to hear Mr. Flagg speak as he did on that furnace proposition. Unfortunately, Mr.

Rutz does not say whether he is running one heat a day or two heats a day in that furnace.

A MEMBER.—He runs two.

THE CHAIRMAN.—Of course, with two heats a day the second heat helps him on his coal ratio, but that 2.75 I think is very good melting. Will somebody answer Mr. Van O'Linda's question? I think that warming up of the furnace before charging is almost obsolete, not entirely, but I think almost so. I think that the people who run an afternoon and a morning heat charge immediately after the heat is out in the afternoon for the morning heat, and there is more or less heat, of course, in the furnace when they get ready. Certainly in the afternoon heat, where the furnace is charged immediately after the iron is taken out in the morning, you have a very strong heat in your furnace and your coal consumption is proportionately small.

MR. P. H. DAVIS.—I was very glad to hear you say that the matter of construction was a thing to take into account. The economy of a furnace is governed by how well you can get the iron over on to the molders' floor. In the case of the company of which I am a part, we make light and medium castings. We have our furnaces set in the shop in pairs, it being 150 feet in width by about 300 feet in length. We have three taps, two on one side and one on the other. We tap at different levels. We charge ordinarily on a cold bottom. We make two heats a day. We run one furnace and when it gives out we switch over to the other. That is our ordinary practice. We do it both ways. When there is any question as to how many molders we are going to have after a picnic or a Sunday or holiday, we heat up the furnace. After we get through at night we put in the heat when the furnace is hot and utilize the latent heat in the furnace. We formerly heated up our furnace before we charged. In the method of charging cold, you can put in the charge and have the iron level. It is a problem to get your iron leveled up in the furnace.

MR. H. COLE ESTEP.—It just occurred to me, in connection with Mr. Davis' discussion, that possibly some of the difficulty due to the excessive labor in operating a large furnace

can be overcome by the adoption of suitable cranes, hoists, etc., for charging the furnace, so that the labor of that end of it can be eliminated to a considerable extent. I should imagine that with a large furnace you would require a considerably more elaborate charging apparatus, possibly, than with the smaller furnaces which many of the malleable foundrymen have been accustomed to. Perhaps Mr. Flagg can tell us whether he has found it necessary to have anything in the way of cranes, hoists, etc., in charging these large furnaces.

Mr. S. G. Flagg III.—We have some rigs that help.—I imagine everybody has the rail over the furnace to take care of the bungs. We have another crane there and that crane is used to help charge the furnace, but I think we would use that no matter how big or small our furnace was. The system of throwing the charge in by hand has never appealed to us, and having had this other rig I think we would continue to use it no matter what the size of the furnace.

The Chairman.—There is so little use for a crane in a malleable iron foundry proper that it seems to me that they hesitate about using a crane where they could use it to good advantage in charging, because the cost of the crane for charging a furnace only a couple of times a day would be quite a serious item and the amount realized on the investment would be comparatively small. While a number of the malleable people have gone into the use of charging machines, I think the general practice is the hand method.

Mr. P. H. Davis.—I am familiar with your shop. I have been there a number of times. Before the fire which burned us out and put us out of the malleable business, we charged the same. We had a laborer to raise the bungs at each end. When we built our new shop—these furnaces stand on a 40-foot bed—we had a 40-foot crane travel down between the furnaces. That crane we operate by hand. We expect eventually to have electrical equipment so that we can handle things more readily, but just now we are going along in as crude a way as we can and we expect eventually to have a model shop.

The Chairman.—For a year or two we have been considering this crane charging proposition, and we are working

on two different ideas now. We have them under consideration and are trying to decide which of the two we will try. As I say, the expense of an electric traveling crane is very great for the amount of work you get out of it, but we have the thing under consideration by two different plans and I think before a great while we will try out one if not both of them on different furnaces.

MR. FRED VAN O'LINDA.—I would like to hear from Mr. Flagg whether he has ever taken up the tram-rail system for conveying iron to the molders.

MR. S. G. FLAGG III.—You mean the overhead rail with the conveying apparatus attached?

MR. FRED VAN O'LINDA.—Yes.

MR. S. G. FLAGG III.—Yes, we use it almost entirely for heavy work. No molder can carry the iron, and you could not afford to have him do it. It would hold back your production and hold back everything. You cannot take a big heat out of a furnace and hope to carry it away with the molders that put the molds up. We put our heavy work away from the furnace and save the molder the trips to the furnace.

MR. FRED VAN O'LINDA.—May I ask how large a ladle you use?

MR. S. G. FLAGG III.—From memory, I think it holds about 400 pounds. I am not quite certain about that figure. It might hold a little more.

MR. FRED VAN O'LINDA.—Is it operated by hand, pushed along?

MR. S. G. FLAGG III.—How do you mean? Pushed on the rail?

MR. FRED VAN O'LINDA.—Yes.

MR. S. G. FLAGG III.—Yes.

A MEMBER.—One of the most modern shops I have seen is at Danville, Ill., where they have a mono-rail system that handles the iron ladles out in the shop and does work of that kind. It is electrically operated by a man in the cab and goes all over the shop.

The Chairman.—I think there are many foundries which use the overhead tram-rail. We use it in connection with two of our furnaces, one an air furnace and the other an open-hearth, and we use, also, this hand rail. Our ladles carry 800 to 1,000 pounds. We use that only, of course, on the heavy work. It is a wonderful economy where you can use it, but we cannot use it on light work. One man pushes the ladle and brings it right to the molders' floor. We have quite a complicated system of turn-tables and switches, but we handle the ladles satisfactorily and rapidly on our heavier line of work.

The Use of Cheaper Materials

By Charles C. Kawin, Chicago

There has been much discussion for and against the use of cheaper materials and it is my intention to give you the results of several years of practical experience in the use of such materials. Cast iron of all descriptions, "semi-steel," malleable, wrought iron and steels of all descriptions, are all members of the same family—the only difference being degree of refinement.

Light castings such as toys, small hardware, sewing machine parts, etc., are made from a mixture of irons, giving a high percentage of silicon, which acts as a softener. There are two general exceptions to this statement that silicon is a softener, the one being the case of excessive silicon in light castings and the other, the very high silicon, special acid-resisting mixtures.

As we pass to the other classes of work, where there is added metal thickness, more strength required per unit of section, or where pressures must be resisted, we gradually reduce the silicon and change the other elements to suit required conditions.

Cheaper Materials May Be Used

It is the writer's opinion that the larger percentage of the total tonnage of castings required in this country could be made, using cheaper materials in excess of 50 per cent in the mixture. Be sure and get this right, because I believe that the castings which run into the heavier tonnage can be made by using large amounts of stove plate, agricultural, machinery, malleable or steel scrap, the amounts depending a good deal upon the analysis of the pig iron which would be used in combination with these scrap materials.

Many foundrymen tell us they dislike to use stove plate, because of slight additional expense in handling; the answer to that is entirely one which can be figured out in dollars and cents.

Again, others say there is too much burned material. Why accept from the scrap dealer such material when you would not accept from the pig iron dealer a quantity of off-grade pig mixed with the iron of your regular specifications? From the other standpoint, stove plate has high silicon and phosphorus and fairly low sulphur, as compared with other scrap materials and as silicon is one of the most important elements in regulating the price of raw materials and consequently has a decided bearing on the cost of a mixture, as well as the fact that its presence is necessary as a softener, the actual benefits derived by the use of stove plate are manifest.

It is not necessary to touch upon agricultural or machinery scrap, because most foundrymen have used it successfully for many years and if you are watching your output carefully, having occasional analyses made you can take more chances on using more scrap than you would otherwise; the idea being that if the scrap resulted in running the sulphur up, it could be dropped out for one day and then continued again for a reasonable length of time. This method has been successfully followed and it has resulted in large savings in many shops.

Going into the use of malleable and steel scrap, we come into a feature which is not new to you, but it has caused you more or less worry, owing to the fact that these are low silicon materials, as well as low phosphorus and low total carbon and unless used properly will cause shrinkage. All of you know that reducing the silicon, phosphorus and total carbon will naturally result in this trouble, but right here I wish to impress upon you that many of you have had trouble when you have had none of these materials in your mixture, and apparently have remedied the trouble by using different pig iron or by making a physical change, that is, changing the gates and risers, and this is necessary when you are using low silicon, low phosphorus mixtures. Steel castings present an extreme example and require heavy gates and risers due to low silicon, phosphorus and total carbon. Going from this extreme through the various classes of castings, malleable, high pressure, machinery, stove plate and finally light hardware,

these elements are increased, resulting in less shrinkage and incidentally the gates are made lighter and risers are decreased, and finally eliminated entirely.

Handling Ill-Proportioned Patterns

The foundryman conducting a jobbing business frequently is compelled to accept ill-proportioned patterns and it is unnecessary to say that where thick and thin sections adjoin each other, the same iron will not suit the purpose, consequently a physical arrangement must be made for taking care of a condition of this kind, in other words, the heavier metal must be cooled proportionately with the lighter metal, if you intend to avoid shrinkages and get satisfactory results.

Frequent inquiries are made as to how much steel can be used in a mixture. The same is true of other materials. In order to answer this question it is necessary to know what the casting is to be used for, what particular tests it must stand, the thickness of the lightest and the heaviest section, the total weight of the casting, the quantity to be made, etc. Of course, a blue print of the casting is to be preferred, but the foregoing information gives a pretty good idea of how to lay out a mixture.

There is no question at all but that total heats of stove plate or malleable scrap or steel can be run. The writer has had experience with a total heat of stove plate. Also 65 per cent of malleable scrap has been used under my direction and 80 per cent of steel has been used very successfully, and in some shops 30 to 50 per cent is being used regularly.

I have frequently been asked whether a mixture containing a large amount of steel and having practically the same amount of silicon, manganese, phosphorus and sulphur as another mixture, which contained no steel, would show a greater shrinkage than the latter mixture. This is a very difficult question to answer, as I do not find equal conditions upon which to make comparisons. Furthermore, some people claim that a mixture with a large amount of steel would naturally have lower total carbon and this would give greater shrinkage. From the other standpoint, it is claimed by some that the same mixture

would absorb sufficient carbon to make up the difference in the figures and consequently there would be no difference in the shrinkage. Personally, I think there is not sufficient difference to give any trouble, but if there is any trouble, a slight change in the gating should suffice.

I want to illustrate before concluding just what can be done when all-scrap materials are used. On the following pages are examples of mixtures that are practical for certain heavier classes of work. Naturally enough we cannot make a suitable stove plate iron from stove plate scrap but I believe you will readily appreciate the point I am driving at.

Table I

ALL-SCRAP MIXTURE CONTAINING STOVE-PLATE AND AGRICULTURAL SCRAP

2.00 Per Cent Silicon in Castings.

Material.	Lbs. per charge.	Silicon, per cent.	Silicon, lbs.	Manganese, per cent.	Manganese, lbs.	Phosphorus, per cent.	Phosphorus, lbs.	Sulphur, per cent.	Sulphur, lbs.
Returns	200	2.00	4.00	0.55	1.10	0.800	1.600	0.140	0.280
Stove plate.......	550	2.40	13.20	0.30	1.65	0.900	4.950	0.100	0.550
Agricultural	250	2.25	5.63	0.30	0.75	0.700	1.750	0.100	0.250
Ferro-manganese..	5†	....	....	80.00	4.00	.....	.....	.....	.....
Total pounds.....	1,000	....	22.83	....	7.50	.....	8.300	.....	1.080
Gross silicon, manganese phosphorus, sulphur.........		2.28	....	0.75	....	0.830	.....	0.108	.....
Loss by oxidation.	10%	0.23	25%	0.19	....	.....	.....	*0.035	.....
Net silicon, manganese phosphorus, sulphur & carbon		2.05	....	0.56	....	0.830	.....	0.143	.....

*Add, from coke. †Weight of ferro-manganese not considered in total.

Since an iron showing 0.70 per cent silicon, 0.50 per cent manganese, 0.325 per cent phosphorus, 0.150 to 0.200 per cent sulphur and 3.40 per cent carbon when poured into a 1-inch square test bar drills very easily with a ⅝-inch drill, and as this mixture is higher in silicon and lower in sulphur, it should be sufficiently soft for castings of 1 inch or more in thickness.

Table II

MIXTURE CONTAINING MALLEABLE AND STEEL SCRAP

1.50 Per Cent Silicon in Castings.

Material.	Lbs. per charge.	Silicon, per cent.	Silicon, lbs.	Manganese, per cent.	Manganese, lbs.	Phosphorus, per cent.	Phosphorus, lbs.	Sulphur, per cent.	Sulphur, lbs.
Returns	150	1.50	2.25	0.55	0.83	0.600	0.900	0.130	0.195
Stove plate	350	2.40	8.40	0.30	1.05	0.900	3.150	0.100	0.350
Agricultural	200	2.25	4.50	0.30	0.60	0.700	1.400	0.100	0.200
Ferro-manganese..	5†	....	....	80.00	4.00	.....	.....	.....	.....
Malleable	200	0.70	1.40	0.25	0.50	0.200	0.400	0.070	0.140
Steel scrap	100	....	....	0.50	0.50	0.080	0.080	0.060	0.060
Total pounds.....	1,000	....	16.55	....	7.48	.....	5.930	.....	0.945
Gross silicon, manganese, phosphor., sulphur.........		1.66	....	0.75	....	0.593	.....	0.095	.....
Loss by oxidation.	10%	0.17	25%	0.19	....	.....	.....	*0.035	.....
Net silicon, manganese phosphorus, sulphur & carbon		1.49	....	0.56	....	0.593	.....	0.130	.....

*Add, from coke. †Weight of ferro-manganese not considered in total.

(See note under Table I.)

Table III

MIXTURE CONTAINING MACHINERY SCRAP WITH MALLEABLE AND STEEL SCRAP

1.00 Per Cent Silicon in Castings.

Material.	Lbs. per charge.	Silicon, per cent.	Silicon, lbs.	Manganese, per cent.	Manganese, lbs.	Phosphorus, per cent.	Phosphorus, lbs.	Sulphur, per cent.	Sulphur, lbs.
Returns	150	1.00	1.50	0.55	0.82	0.425	0.637	0.125	0.187
Mchy. scrap	400	2.00	8.00	0.30	1.20	0.700	2.800	0.100	0.400
Malleable	300	0.70	2.10	0.25	0.75	0.200	0.600	0.070	0.210
Steel scrap	150	....	....	0.50	0.75	0.080	0.120	0.060	0.090
Ferro-manganese..	5†	....	....	80.00	4.00	.....	.....	.....	.....
Total pounds	1,000	....	11.60	....	7.52	.....	4.157	.....	0.887
Gr. silicon, manganese phosphorus, sulphur.........		1.16	....	0.75	....	0.416	.....	0.089	.....
Loss by oxidation.	10%	0.12	25%	0,19	....	.....	.....	*0.035	.....
Net silicon, manganese phosphorus, sulphur & carbon		1.04	....	0.56	....	0.416	.....	0.124	.....

*Add, from coke. †Weight of ferro-manganese not considered in total.

(See note under Table I.)

Table IV

MIXTURE CONTAINING 75 PER CENT SCRAP AND 25 PER CENT PIG

2.00 Per Cent Silicon in Castings.

Material.	Lbs. per charge.	Silicon, per cent.	Silicon, lbs.	Manganese, per cent.	Manganese, lbs.	Phosphorus, per cent.	Phosphorus, lbs.	Sulphur, per cent.	Sulphur, lbs.
Returns	300	2.00	6.00	0.45	1.35	0.600	1.800	0.120	0.360
Machinery	300	2.00	6.00	0.30	0.90	0.700	2.100	0.100	0.300
Steel scrap	150	....	....	0.50	0.75	0.080	0.120	0.060	0.090
Pig, southern.....	250	4.25	10.62	0.95	2.37	0.900	2.250	0.030	0.075
Total pounds	1,000	....	22.62	....	5.37	.....	6.270	.....	0.825
Gr. silicon, manganese phosphorus, sulphur.........		2.26	....	0.54	....	0.627	.....	0.083	.....
Loss by oxidation.	10%	0.23	†15%	0.08	....	.....	.....	*0.042	.....
Net silicon, manganese phosphorus, sulphur & carbon		2.03	....	0.46	....	0.627	.....	0.125	.....

*Add, from coke. †Lower manganese loss by oxidation due to absence of ferro-manganese in mixture.

(See note under Table I.)

Discussion—The Use of Cheaper Materials

The Chairman, B. D. Fuller.—This raises a question which should be of interest to the foundrymen, as to just how far we can go in this direction.

Mr. Henderson.—What percentage of carbon would there be in ordinary cupola practice using 8 per cent steel?

Mr. C. C. Kawin.—The mixture referred to is being used in making chilled rolls, 2.25 to 2.75 per cent. I do not think the chemists can make total carbon determinations accurately. Now that we have some chemists here, I repeat that statement. If you want me to explain it, I will be glad to. We use an electric furnace for determination and we use 0.3 to 0.5 of a gram, but there is a variation in the sample; there is a certain amount of free graphite there which is very difficult to pick up with a spatula or knife so as to get a uniform sample. You might at one time get a sample with little free graphite and at another time more. I think it is impossible to get an accurate determination. I can tell you whether the carbon is 3.20 or 3.60, but as to telling whether it is 3.40 or 3.50, I cannot guarantee to tell that. I do not think it is a question of the chemists being able to work the total carbon at all. I think it is a question of the method.

Mr. J. D. Stoddard.—We know whether the total carbon is 2.25 or 2.35 and that is sufficiently close for all practical purposes, and I do not think the fact of not being able to get the total carbon in gray iron within the limitation we ought to get it in steel ought to worry any of our chemists at all.

Mr. C. C. Kawin.—It is not worrying us. I wrote a letter about two years ago acknowledging that our determinations were incorrect, much as I hated to do it after I found that was the case. I told them they could pay their money and take their choice. As I say, we can tell possibly within 10, 15 or 20 points, but I feel satisfied that everybody agrees that the low

silicon and low phosphorus material would run higher in total carbon, and that is a good guide to go by. That is, referring to pig iron. That is a good base to work on.

Mr. J. D. Stoddard.—I think that foundry laboratories spend a great deal of useless time and energy by running carbon tests. I believe the old method for graphite determination and for combined carbon, if properly carried on, is sufficient for all practical purposes, and I do not believe it is necessary to spend the time or money for equipment that is being done in some foundries.

Mr. C. C. Kawin.—You refer to the old Swedish method. I have worked at it years ago and we could not get a result for three weeks.

Mr. Marcus.—My experience is that the silicon and carbon ratio is one of the most important things to consider and a variation of 10 to 15 points, as we usually find in pig iron, would make quite a difference, especially when you are working on a very close margin. It depends on what you are doing. In gray iron work I do not believe it is absolutely necessary, but in malleable iron practice I have found it is best to be on the safe side, especially where you are running on a very close margin.

Mr. C. C. Kawin.—We do not make the graphitic carbon determination. We make five determinations on heats and four determinations on pig iron. Some of our clients insist on total carbon determination; otherwise we make no determination on heats for graphitic carbon. That is why I made the acknowledgment two years ago. That is nothing new. We learned a few years ago from the Chemical Society that a lot of our tables were wrong, after some hundreds of years' study, so I did not consider it a disgrace to make the acknowledgment. I felt it was a benefit to the foundrymen.

Mr. Marcus.—It entirely depends on what you are doing In malleable practice I find from 10 to 15 points makes quite a difference.

Mr. C. C. Kawin.—Did I understand you to say that in cases where you require close work you would insist on total carbon determinations? I could not give it to you.

MR. MARCUS.—You can give it a little more accurate with a 10-gram sample.

MR. C. C. KAWIN.—On what method would you use the 10-gram sample?

MR. MARCUS.—The ordinary method. Of course, it will take you longer.

MR. C. C. KAWIN.—I do not remember just exactly how many weights we had in that determination. As I recollect, we used to weigh a filter paper and then we weighed a filter paper afterwards. I believe it is absolutely impossible to make accurate determinations.

MR. MARCUS.—If you took a larger sample, your liability to error is smaller.

MR. C. C. KAWIN.—In your other method you have so many other things to contend with in the way of iron on your paper and your many weights that it makes it absolutely impossible. You have got to dry it in an air bath. You can dry a paper and get one weight and then if you dry it 15 minutes more you would get another weight.

THE CHAIRMAN.—I was going to inject the remark that this is very enlightening, this matter of analysis. If you keep on, somebody will be telling the truth before long. I think Mr. Kawin's paper has a very practical side, the use of cheaper material, and one that was well worthy of consideration. I am willing to say that I ran our works, the heavy part of it, for an entire year on better than 75 per cent scrap and turned out good castings. It was rather a matter of compulsion, brought about by the panic, a thing of the past. We quit buying pig iron and used up all the scrap we had in the shop, and that was an actual fact that our entire year's melt ran better than 75 per cent scrap.

How Some Cleaning Room Problems Have Been Solved

By H. Cole Estep, Cleveland

Many writers have indicted the foundry industry for its lack of progressiveness in the adoption of modern methods and labor-saving appliances. A decade or so ago these accusations were well founded, but in recent years so much attention has been focused on the advantages of machine molding and mechanical methods of handling materials, that today there are few foundrymen who do not appreciate the necessity for up-to-date equipment.

In the march of progress, however, there is one important department that until recently has lagged behind—namely, the cleaning room. The relative lack of advancement in this direction is attested by the fact that as late as 1903 we find the cleaning department referred to as the "scratch room", indicating that the methods of at least some foundrymen prominent enough to voice their opinions in the technical press had not advanced beyond the wire brush stage.

Since that time, however, such tremendous forward strides have been made in the development of adequate cleaning-room appliances and methods that today this department of the foundry is virtually as thoroughly modernized as any other. But this progress has been so rapid that its whole significance has not yet been fully grasped in all quarters, with the result that many foundrymen have failed to take advantage of the methods and apparatus now available. This is partly due to the fact, also, that attention has been centered largely on molding practice, methods of melting or other seemingly more important questions, with the result that the literature of cleaning-room practice is exceedingly meagre.

It is the purpose of this paper to outline in a general way how certain representative foundries have solved their cleaning-

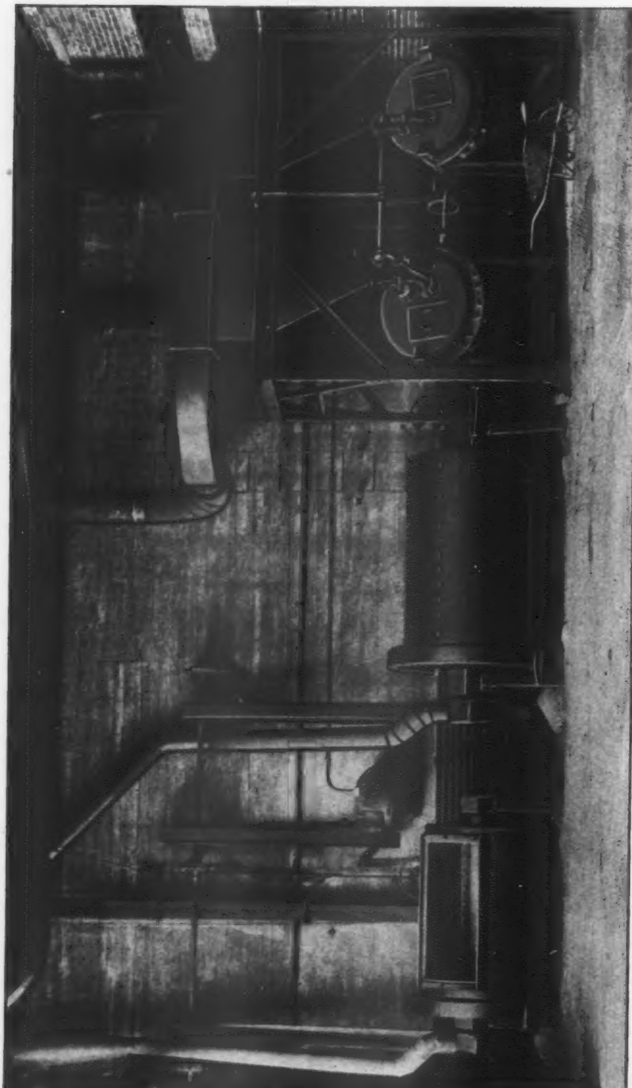


FIG. 1—CLEANING ROOM IN A GRAY IRON JOBBING FOUNDRY CONTAINING TUMBLING MILLS AND SAND-BLAST APPARATUS

room problems, with the hope of calling attention to the importance of this phase of foundry activities. The paper also may serve to indicate some of the advances that have been made in the past few years in the development of efficient labor-saving appliances for cleaning-room service.

Sand Blast a Great Labor Saver

At the outset it may be well to state that the sand-blast will be touched upon only incidentally. The subject of sand-blasting is such a large one in itself that to include it would extend this contribution beyond reasonable lengths. It will be sufficient to say that practically no modern foundry is complete without a sand-blast installation. While it is not believed that sand-blasting will supersede other cleaning methods, such as rumbling, it undoubtedly is the method *par excellence* for many classes of work, particularly where an exceptionally fine finish is desired. On account of the excellent surface imparted by the sand-blast, this method of cleaning has all but driven the time honored pickling vat out of the modern foundry.

Aside from the sand-blast, the tumbling mill is the most universally used cleaning-room appliance. In many foundries, particularly gray iron shops handling miscellaneous work, tumbling mills and sand-blast machines are operated side by side. In fact, this may be considered the ideal arrangement for a jobbing foundry. A typical installation of this character, in a prominent Milwaukee gray iron foundry, is illustrated in Fig. 1. As the illustration shows, the installation includes two motor-driven tumblers and two automatic sand-blast barrels. The smaller tumbling mill is 36 x 48 inches and the larger one 42 x 72 inches. The sand-blast barrels are of a standard type, each one being capable of cleaning approximately 500 pounds of castings in from 15 to 20 minutes.

This apparatus takes care of the work for a gray iron foundry with a molding floor area of 24,700 square feet. The shop has an average output of 35 tons of castings per day; some of them, however, are of such a size that ordinary cleaning-room methods are not applicable.

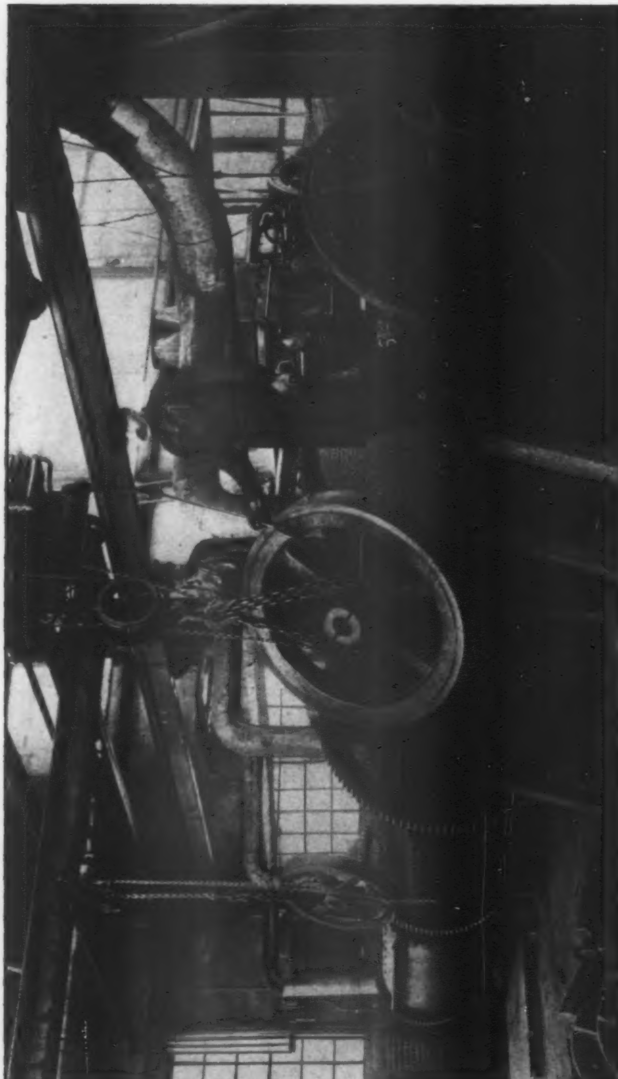


FIG. 2—LARGE TUMBLING MILLS FOR HANDLING HEAVY GRAY IRON CASTINGS

The cleaning room shown in Fig. 1 connects directly with the molding floor and is served by a 5-ton traveling crane with a span of 38 feet. For convenience in chipping work, the room is provided with numerous compressed air outlets. Incidentally it may be stated that very little data is available covering the quantity of work which cleaning-room apparatus should be expected to turn out. One authority states that two men should be able to keep six 36-inch rumblers going steadily.

FIG. 3—A BATTERY OF MOTOR-DRIVEN TUMBLING MILLS IN A LARGE GRAY IRON FOUNDRY MAKING SMALL CASTINGS FOR ELECTRICAL APPARATUS

Tumbling mills were designed originally for cleaning small castings. Gradually, however, the size of the mills has been increased, until today equipment is available for handling castings weighing several hundred pounds. A battery of large tumblers for handling heavy gray iron castings is shown in Fig. 2. This equipment is installed in the shop of a manufacturer of kerosene-driven farm tractors. The mill shown at the right in Fig. 2, on which the man is standing, is 60 inches in diameter and 72 inches in length. The square tumbler shown

immediately at the left is only slightly smaller. If heavy work is to be handled satisfactorily in large tumbling mills it is necessary to provide suitable cranes and hoists, similar to those shown in Fig. 2, for handling the castings.

The foundry in which the mills shown in Fig. 2 are installed has a molding floor area of approximately 36,000 square feet. This shop was designed for an output of 100 tons per day. The castings vary from large crank cases weighing 1,800 pounds each to small engine parts averaging over a thousand to the ton. The cleaning room is equipped with eight tumbling mills similar to those illustrated in Fig. 2. They are gear-driven by a 10-horsepower motor. This department also is equipped with four grinders driven through a line shaft by a 30-horsepower motor. A 40-horsepower motor operates the fan in the dust collector system. Each tumbling mill is connected to the dust-exhaust fan by direct piping. The dust is discharged into bins situated outside the shop. These bins are provided with hopper bottoms equipped with suitable valves and chutes so the dust may be drawn off into cars and conveniently carried away.

Power Required for Tumbling Mills

In connection with the power required for operating tumbling mills, some data prepared by Lockwood, Green & Co., Boston, are interesting. The investigation was conducted to determine the feasibility of replacing three separate power plants with one central plant in a large manufacturing works. The tumbling barrels were arranged two on a shaft, the size of the barrels being 36 and 40 inches in diameter. As a rule only one barrel was loaded, although about 25 per cent of the time both were operated. It was found that the average power demand was 4.3 horsepower while the maximum with both barrels loaded was 5.8 horsepower. The shafting with the barrels running light required 2.75 horsepower; with the smallest barrel filled and the larger one empty, the total power necessary was 4.15 horsepower, while with the larger barrel filled and the smaller one empty 4.45 horsepower were required. It was

decided that a 5-horsepower squirrel-cage induction motor would be ample for driving these two barrels.

For handling medium-sized gray iron castings in large quantities open-ended continuous tumbling mills have been installed in a number of foundries. A large mill of this type, 36 feet long and 28 inches in diameter, is in operation in an Indiana implement foundry. The outlet of the barrel is provided with a door which can be adjusted at any angle to regulate the discharge of the castings. The castings are charged at one end of the barrel and discharged from the other, the desired incline being secured by two jacks which elevate the entire machine. The exhaust hood is placed near the front end where the castings receive the first cleaning as it has been found that the largest amount of dust accumulates at this end. The barrel is of steel plate construction 1 inch thick and six staggered ribs are riveted to the inside throughout its entire length to prevent the castings from sliding. The mill is belt-driven and in addition to the spur gears on the barrels, two welded tires are provided which rest on roller bearings.

Where an exceptionally large number of small castings are produced every day, elaborate facilities are necessary for cleaning the product, as well as for grinding, chipping and sorting. An unusually complete cleaning room for handling small gray iron castings for electrical apparatus is shown in Figs. 3 and 4. This cleaning room is operated in conjunction with a continuous foundry turning out approximately 40 to 50 tons of castings per day. The plant runs 52 hours per week and from 35 to 50 castings are shipped every minute. The cleaning room equipment includes both sand-blasting apparatus and tumbling mills. The former consists of two sand-blast rooms equipped with pressure type machines together with a large rotary-table sand-blasting machine. The general arrangement of the tumbling mill equipment is shown clearly in Fig. 3. Twenty mills have been provided, arranged in two groups of 10 each. The mill room is served by a monorail system which is employed to transfer the castings from the molding floor to the cleaning department. The cleaned castings are delivered directly to the

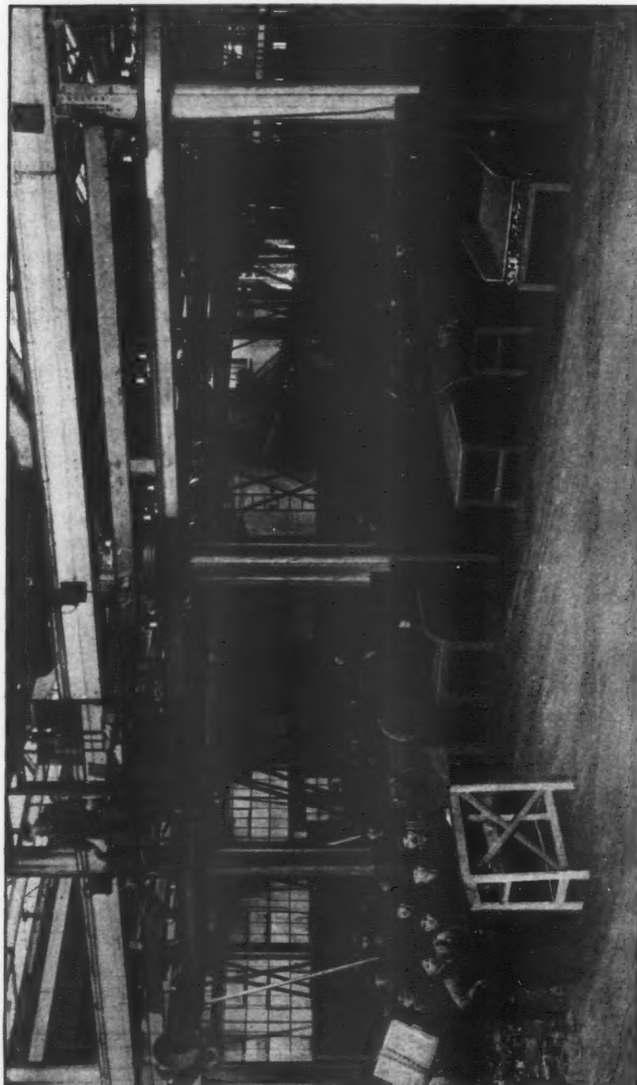


FIG. 4—GRINDING AND SORTING ROOM OPERATED IN CONNECTION WITH THE TUMBLING MILL INSTALLATION ILLUSTRATED IN FIG. 3

chipping and grinding benches, which are located alongside the tumbling mills.

Sixteen double emery grinding stands have been provided. They are arranged in four rows facing the chipping benches, as shown in Fig. 4. An endless pan type conveyor parallels each row of grinding stands. These conveyors discharge the finished castings onto the aprons shown in the foreground of Fig. 4. The conveyors, which operate at a speed of 28 feet per minute, are driven by 3-horsepower motors running 1,130 revolutions per minute. The conveyors are 40 feet in length overall. The finished castings are discharged on the shipping platform directly opposite the outgoing railroad tracks. The entire cleaning room equipment in this foundry is unusually well arranged and the shop affords an excellent example of the facilities necessary for handling a large number of small castings daily.

Motor-Drive is Favored

In Fig. 3 it will be noted that line shafts and belts are conspicuous by their absence. There is a decided tendency at present toward the use of individual motor drives for cleaning room apparatus. This is in sharp contrast to previous practice, for as late as 1907 line shafts and belts were used in an overwhelming majority of installations.

The superintendent of a shop turning out exceptionally heavy castings, such as large engine beds, heavy fly wheels, etc., is forced to adopt cleaning methods that are radically different from those employed in foundries making light castings exclusively. It usually will be found that the sand-blast room offers the best solution of the problem in this case. In some instances, however, the castings are too large even to be sandblasted. In this case, it is advisable to use the best possible mold facings and to clean the castings, where necessary, with the old-fashioned scratch brush.

An unusually interesting method of cleaning and removing the cores from large castings by hydraulic power has been developed by James A. Murphy, Hamilton, O. The castings are removed to the yard where they are treated with a heavy stream of water pumped through a fire hose. Suitable chutes and

flumes are provided for carrying off the surplus water. This method has been found to be very efficacious. The disintegrating power of a heavy stream of water is well understood and the castings come out of their bath thoroughly cleaned and freed from sand.

In recent years, a new type of foundry has been developed in which the central cleaning room is entirely eliminated. These

FIG. 5—CASTING CLEANING AND GRINDING UNIT UNDER MOLDING FLOOR IN AN IMPLEMENT FOUNDRY

shops are operated on the unit principle, each molding and cleaning unit being complete in itself. Such arrangements are particularly satisfactory for handling large quantities of comparatively light gray iron castings such as agricultural implement and automobile parts. A typical cleaning installation of this character is shown in Fig. 5. This shop, which is located in Illinois, is designed for a production of 100 tons per day. The foundry building proper is two stories in height, 60 feet wide and 340 feet long. The cleaning apparatus is located on

the lower floor. The castings are transferred from the molding floor to the cleaning units through chutes shown at the rear in Fig. 5. These chutes are cast iron, inclined downward at an angle of 25 degrees to the foundry floor and inward at an angle of 30 degrees. The castings are deposited on a landing table which is fitted with a grating bottom that allows

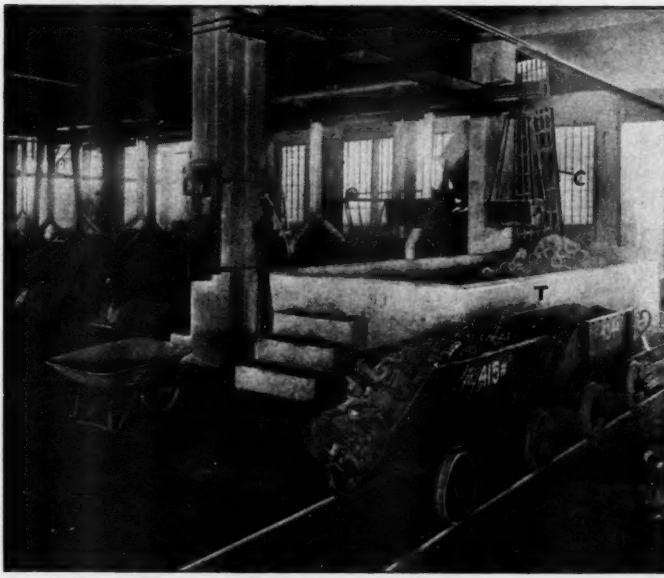


FIG. 6—GENERAL VIEW OF CLEANING APPARATUS IN A TWO STORY IMPLEMENT FOUNDRY SHOWING RECEIVING TABLE AND TUMBLING MILLS

all loose sand to be collected and returned to the sand heap instead of going into the tumbling mill and wasted. Below and in front of the landing table is located a motor-driven steel plate tumbling mill, 30 inches in diameter and 60 inches in length. This mill is direct-connected to a 5-horsepower induction motor. It is located on a platform 3 feet 6 inches above the floor, as shown in Fig. 5. The platform is fitted with self-dumping buckets and steel barrels that discharge into a receiv-

ing basin at the front end. Directly in front of the platform is a single-end, roller-bearing, motor-driven grinder of special design. The chutes or inclines are designed and used as casting cooling reservoirs and have sufficient capacity to accommodate a five-hour maximum production of the molding floors. They also are placed at such an angle as to allow the castings to slide easily but to avoid breakage due to impact. This unit handles the output of four machine molding floors. Some of the castings are larger than those shown in Fig. 5. These castings are milled in steel plate tumblers 40 inches in diameter and 60 inches long driven by 7½-horsepower induction motors. Each unit of four heavy-work molding floors is equipped with two mills of this type.

The exhaust from the tumbling mills is handled by small unit system. Each unit is designed to take care of the exhaust from five casting cleaning sections, or 20 molding floors. It consists of a section of piping connected to the tumbling barrels and to a No. 3 sirocco blower which discharges into a dust reservoir located 80 feet from the foundry building. The blower is direct connected to a 5-horsepower induction motor and handles all the dust-laden air directly through the wheel. The dust receiver is a large sheet metal box with overhanging hood and two discharge spouts leading from the bottom. Connection also is made by the same system to the grinding wheels located at the tumbling barrel installations. The cleaning department is kept remarkably clean, since the air is changed every seven minutes.

The grinding work is handled by machines located at each mill installation. This arrangement is clearly shown in the foreground of Fig. 5.

In the foundry of the Ford Motor Co., Detroit, the unit system also is employed. This foundry, therefore, has no cleaning room in the ordinary sense of the word. A battery of tumbling mills is operated in connection with each of the molding units. The mills are situated as close as possible to the point where the molds are produced. All of the work in

this shop is cleaned in tumbling mills including the cylinders, and the sand-blast is not employed. This shop melts from 190 to 200 tons of pig iron daily.

Cleaning Castings in a Continuous Foundry

Another interesting cleaning installation in a continuous foundry is shown in Fig. 6. This illustrates the cleaning room of a prominent agricultural implement foundry situated in eastern Iowa. This shop is designed for an output of 40 tons per day, making castings weighing up to 75 pounds. The molds are handled on a turntable 85 feet in diameter. The cleaning department is on the ground floor underneath the molding room. The chute which conveys the castings from the molding floor is shown at *C*, Fig. 6. A concrete landing table *T* provided with a sand bed is placed at the lower end of the chute to receive the castings. Immediately behind the table are 16, 36 x 45-inch tumbling mills arranged in two groups of eight mills each. Each group is belt-driven through countershafting from an electric motor suspended from the ceiling of the room. Four I-beam monorails extend from the receiving table *T* to the tumblers, and the castings are carried from this table to the mills in self-dumping steel buckets as shown in the illustration. The dust from the tumbling mills is collected in two dry-screen type dust arresters.

Behind the tumblers are a row of seven double emery grinding stands. Each wheel is thoroughly protected and provided with an exhaust connection which effectually removes all the dust. The grinding apparatus is driven through countershafts by a single three-phase motor. After the castings are ground, they are removed in wheelbarrows or small buggies and prepared for shipment.

Cleaning Stove-Plate

Stove foundries have solved their cleaning room problems largely through the use of tumbling mills supplemented by sand-blast appliances. A portion of the cleaning apparatus in a large eastern stove plant is shown in Fig. 7. The cleaning equipment in this plant includes one 48 x 48 x 64-inch and two 42 x 42 x 64-inch square tumblers, together with two 36 x 59-inch, four 24 x 35-inch, two 20 x 42-inch and four 34 x 54-inch

round barrels. These machines all are provided with guards to protect the workmen from exposure to the gears. For handling the covers, differential chain hoists, shown in Fig. 7, are used. The cleaning room also is provided with three emery wheel stands which are belt-driven by a 5-horsepower motor. For operating the tumbling barrels, one 15-horsepower, one 7½-horsepower and two 10-horsepower motors are provided. The good castings, as shown by the gangway count, are delivered to the cleaning room in buckets suspended from the

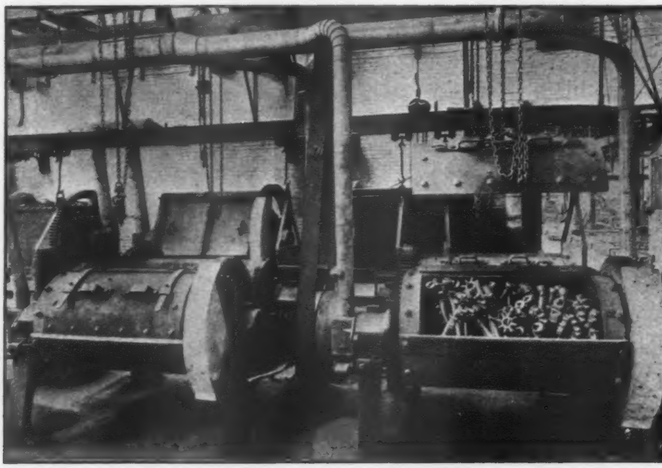


FIG. 7—A TYPICAL TUMBLING MILL INSTALLATION IN A MODERN STOVE FOUNDRY. THE COVERS OF THE MILLS ARE HANDLED BY TRIPLEX HOISTS

I-beam trolley shown in the rear of Fig. 7. This shop melts about 30 tons of iron per day.

An interesting special tumbling barrel for cleaning moderate sized steel castings is shown in Fig. 8. This barrel is mounted on friction drive rollers operated by a 25-horsepower motor. After the castings have been cleaned, the barrel is lifted from the rollers and carried to a convenient point for dumping. In the meantime, another barrel has been filled and is placed in position on the driving rollers by a crane. Three barrels are used altogether and the cleaning operation is continuous. The

barrels are 10 feet 6 inches long, 5 feet in diameter and are constructed of $\frac{1}{2}$-inch steel plates reinforced inside with removable landings and false heads.

How Malleable Castings Are Cleaned

In malleable foundries, where tumbling mills are used for cleaning purposes, two sets or batteries of mills usually are

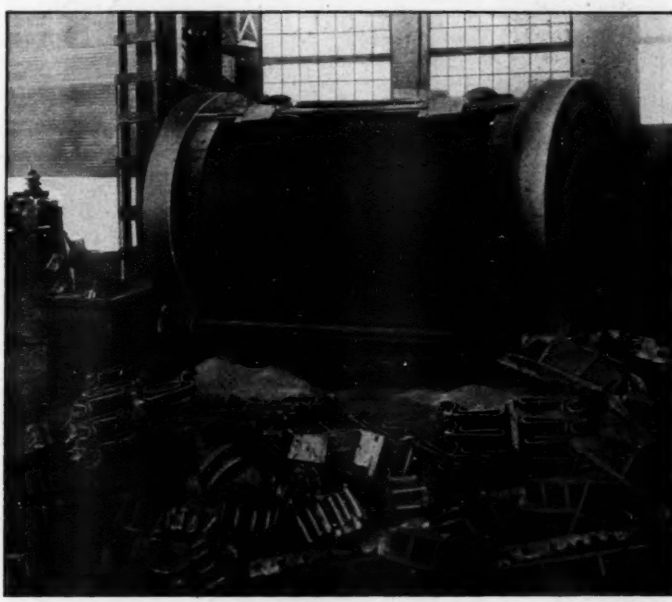


FIG. 8—LARGE TUMBLING MILL OF SPECIAL DESIGN INSTALLED IN A STEEL FOUNDRY

required. One set is employed for cleaning the hard castings and the other for rumbling the annealed product. Fig. 9 shows the cleaning room in which the annealed castings in an Illinois malleable foundry, with a capacity of 40 tons per day, are handled. This installation includes ten $30\frac{1}{2}$ x 40-inch tumbling mills driven through a line shaft and gearing by a 30-horsepower motor. Each tumbler is provided with a friction clutch so that it may be stopped and started individually. An efficient

FIG. 9—SOFT-IRON CLEANING ROOM IN A MODERN MALLEABLE FOUNDRY

dust-exhaust system draws the dust out of the tumblers and keeps the cleaning room clear. The dust-collecting equipment is located just outside the building and is operated by a 10-horsepower motor direct-connected to an exhaust fan. The rapping device for loosening the dust from the cloth screens is actuated by a system of gearing connected to the motor.

Before being delivered to the soft-iron cleaning room, the castings are given a preliminary cleaning in a shaker installed

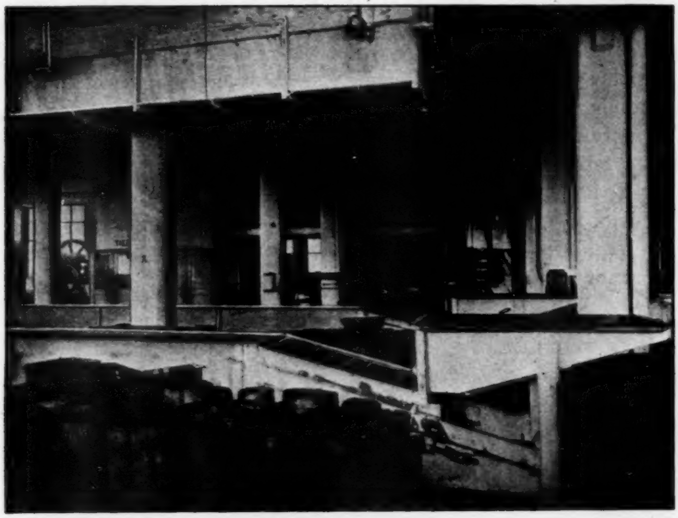


FIG. 10—SORTING TABLES IN A LARGE MALLEABLE FOUNDRY MAKING PIPE FITTINGS

in the annealing room. This device consists simply of an oscillating screen driven through a friction clutch by an electric motor. The annealing pots, two at a time, are picked up by 2-ton floor-operated monorail hoists and suspended over the shaker. While in this position they are hammered with a sledge until the castings and packing fall out. The shaker is then set in motion and the packing sifts out, leaving the partially cleaned castings on the screen. The frame of the shaker is heavily built of steel plate and angles and the screen consists

of a ¼-inch plate punched full of ½-inch holes. This screen is 56 inches long and 45 inches wide. The oscillating motion is transmitted by an eccentric on the motor shaft. A 5-horsepower, 60-cycle, alternating current motor running 900 revolutions per minute is utilized to drive the machine.

In large malleable foundries the problem of sorting the castings after they have been cleaned is a serious one. Fig. 10 illustrates a continuous sorting table installed in the malleable foundry of the Crane Co., Chicago. As this illustration shows clearly, the sorting table is of the endless, motor-driven, pan type. A hopper is provided at the one end of the table in which the castings are dumped as they are received from the tumbling mills. Steel barrels similar to those shown in the foreground of Fig. 10 are used for transferring the castings. The table moves slowly and the workmen, who are arranged along both sides, have no difficulty in sorting out the castings. This shop makes pipe fittings exclusively and the sorting tables are employed for the purpose of assembling the finished fittings according to size.

Report of Work on Molding Sand

By S. W. Stratton, Washington, D. C.

At a meeting of a committee of the American Foundrymen's Association, held at the Bureau of Standards, Washington, D. C., Jan. 10, 1916, the discussion of what constitutes a good molding sand was taken up and it was proposed to prepare an artificial molding sand. The steps that have been taken consist of the Bureau of Standards having received samples of Ottawa sand, mine run, which has been separated into three separate parts in accordance with the instructions of the committee as to the classification, that is, sand suitable for fine, coarse and medium castings. Then these three groups of the Ottawa sand were sent to the clay products laboratory for intimate mixture with the clay which is to be used for this purpose. The clay products laboratory, owing to the pressure of urgent tests and investigations, has been unable, up to the present, to prepare the molding sand mixtures as planned, but will do so shortly. It was proposed, after the clay and the sand had been mixed, to give the products the regular mechanical analysis by means of the sieve test, also tests as to permeability by water under pressure, and the transverse test as to the strength of a bar of sand, 1 foot long and 1 square inch in cross-section. Finally, it is to be subjected to the bonding test, as suggested by the committee and any other tests that may be considered necessary to establish the physical properties of the molding sand as it has been prepared.

Report of the A. F. A. Advisory Committee to the United States Bureau of Standards

Shortly after appointment, the members of your committee with President Bull, met Director Stratton and several of the physicists of the bureau of standards directly interested in foundry problems, at a conference specially arranged for the purpose of planning the investigations desired.

The particular division of foundry work in which it seemed to the committee that the bureau of standards could be of great assistance, can be summed up in the standardization of the materials for making and finishing sand molds. Broadly speaking, what is wanted badly is a "fool-proof" molding sand—meaning thereby a sand capable of being pounded exceptionally hard and yet retaining enough venting power to give good results.

To Prepare an Ideal Molding Sand

Enough is now known on the molding sand question to allow the laying out of definite lines of study, and the joint meeting in question led to the adoption of the plan of preparing what might be called an "ideal" molding sand—one having grain size, clay bond, refractoriness, etc., at the best point attainable. Such a sand, or rather series of sands, would then form definite standards, readily reproduced at will, with which the natural sands can be compared and studied with a view of betterment and adaptation for the several requirements of the industry.

Such a thing as the proper "grain-size" of a molding sand, now a matter of arbitrary and often meaningless numbering by sand merchants, requires standardization. This at once emphasizes the necessity for standard sieves. A special meeting was called by the bureau of standards of representatives of

more than a dozen industries requiring standard sieves, and the problems of wire sizes and apertures were thoroughly gone into. An agreement was reached regarding the policy of the bureau, and studies are being conducted looking toward the ultimate adoption of a uniformly increasing wire-thickness and mesh size, irrespective of the unsatisfactory existing systems.

The question of bonding power on the part of the clay substance in molding sands and the proportion of clay to quartz grains must be studied, for it would seem much better to have a small percentage of a fat, sticky clay bonding the quartz grains together than a large percentage of a lean, non-adhesive material. The working out of rapid shop methods, as well as accurate laboratory tests, by which the clay percentage and its bonding value can be determined as shipments of molding sand are received, will reflect their value in the saving of castings otherwise lost through weak sand.

The matter of refractoriness of molding sands must come in for experimentation, as this in turn is a function of the thickness of section. The famous Albany sands, in their finer forms, are so full of fluxes that they are useful only for very light sections. Again, the shape of the quartz grain and its surface condition, whether rough or smooth, must be studied, so that the bearing of every property possessed by a molding sand as affecting its ultimate value can be readily appraised.

In short, the problem seemed to resolve itself into the preparation of an artificial molding sand, or series of sands, and this work is now being prosecuted. A special report on the detailed steps taken along this line has been promised for the convention by the bureau, and hence your committee simply reports progress.

Mold Finishing Problems

The committee has in view the working out of mold finishing problems in the foundry. The function of "sea-coal" in facing has never been explained authoritatively. Indeed, present practice is looking toward the elimination of this bond-weakening material in molding sand. As it must, however, be replaced by skin finishes of some kind, a study of the best methods of

applying graphite and other smooth refractories is very necessary. Not only must the application of graphite, soapstone and other skin finishes be understood to get satisfactory results, but these materials must also be standardized and specifications written for their purchase. Much work is therefore still ahead, and it is hoped that every foundry laboratory will conduct investigations, and every foundry foreman will try out his ideas along this line of thought. The publication of the results in the trade journals, or at conventions, will enable the foundryman to grasp the underlying principles involved, and the entire industry will move another step ahead.

Your committee would like to have the questions brought out in this report discussed, so that further ideas may be at its disposal in developing the work entrusted to its care. The individual members wish to express their special thanks for the whole-hearted reception given them and their suggestions by Director Stratton and his associates, and look for very interesting and valuable results to follow.

RICHARD MOLDENKE, Chairman,
W. M. SAUNDERS
H. E. DILLER

Discussion—Report of A. F. A. Advisory Committee to the U. S. Bureau of Standards

Dr. Richard Moldenke.—The report of the Advisory Committee to the Bureau of Standards is printed and you can read it at your leisure. We had the first meeting in Washington and with the Director and his associates had a very instructive day, going through this subject thoroughly. The results, as far as we have gone, have been reported by Mr. C. P. Karr. Since that time there have been other meetings, and one of the subjects discussed was the question of the "sizing" of molding sand. This brought out the importance of having "standard" sieves, meaning thereby standardizing the sizes of the wire and the sizes of the openings in a set of standard sieves. We have had a number of meetings and tried to formulate some relation between the sizes of the wire and the sizes of the openings, starting with say the 250-mesh sieve for cement and going up to the very coarsest sizes which are used in various industries. The sub-committee appointed for this work took into consideration the existing customs and standards, and formulated a report which was sent me this morning. This report is rather elaborate and is going to be submitted to the entire Committee for adoption. However, I was requested upon coming here to the meeting of the American Foundrymen's Association to try to get some action on the matter now because otherwise a whole year will be lost. This report of the sub-committee will undoubtedly be adopted by the general committee, and it will have then become the government standard for all sieves. The Bureau of Standards would like to see the different associations representing the various industries affected by this standardization, adopt such a report also. I would like very much if the Association would pass a resolution authorizing the Executive Board to

accept the standards selected by the Bureau of Standards, so that we could be placed on the list of industries that have adopted standard sieves in our work.. Just a week ago Director Stratton wrote me, stating that the question of sieves had brought up the matter of standardizing sands in general. As you all know, the various producers use different numbers. For instance, you may get a No. 4 sand in New England which would be entirely different in grain size from a No. 4 of some other section. Hence the Director asked the Committee of the American Foundrymen's Association to undertake to standardize the sizes of sands that are sold for sand blast purposes, cores, etc., in addition to the molding sands. I have suggested that instead of numbering them they be lettered, as A, B, C, D, etc. Now, Mr. Chairman, I would like to move that the Executive Board of the American Foundrymen's Association be empowered to adopt the standard sieves selected by the United States Bureau of Standards, as the standards of the Association, at such time as they may be presented for consideration.

Motion seconded and adopted.

THE CHAIRMAN, R. A. BULL.—We would like to have some remarks on Dr. Moldenke's report. I might say that I have had the pleasure of attending personally one of the conferences at the Bureau of Standards and was there given an opportunity of seeing the very hearty co-operation of the Bureau with our Committee. I think it is going to be productive of a whole lot of good.

DR. RICHARD MOLDENKE.—If you read through the report you will notice that the whole tendency was toward artificial molding sands. This is the case in Europe, and you know it is very important in our business to have a sand with round grains of a uniform size, each grain coated with the least amount of best possible clay. This is the best definition of the ideal molding sand. This problem may be best solved by having an artificial sand. I would request you all to study the situation very carefully.

Waste Foundry Sand

By H. B. Swan, Detroit

The subject of waste foundry sand and the problem of its reclamation is not a new one to members of this association. The idea of the writer in again bringing this subject before you is not to present any new data, original with himself, but to urge forward the ever growing importance and need of systematic research to determine the possibility of reclaiming in a practical way the vast volumes of used molding and core sands, especially the latter, which are daily being thrown away as waste material.

For the purpose of determining the status of the waste sand problem throughout the foundry industry, and more as a "feeler" than for any scientific record, the writer had sent out to a number of our large foundries the following set of ten questions.

1.—How much sand do you use (in tons) per day?
2.—How much new core sand do you use per day?
3.—Is your foundry practice green sand or dry sand molding?
4.—Do you use oil or other materials for core binders?
5.—How much refuse sand do you dispose of daily (tonnage)?
6.—How do you dispose of it? (That is, do you load it on cars on your siding, or haul it away in wagons? Any details will be of additional value.)
7.—How much do you know or estimate it costs you per ton to dispose of it?
8.—Do you make use of any of your old core or molding sand? If so, what percentage?
9.—How much could you afford to pay for treating and using the whole or a portion of your old sand as against the cost of new sand?
10.—Any information which you may add, bearing upon the above questions, will be appreciated and used, without mentioning names, in the investigation of a method to make use of the foundry refuse sand, and open to members of the A. F. A. through its transactions.

Old Core Sand is Wasted

The answers to questions Nos. 1 and 2 of course varied with the size of the foundry and the character of the work. To question No. 3, green sand molding is by far in excess of

dry sand work, save in the steel foundries. In reply to question No. 4, oil, flour and pitch seem to be in almost universal use, all of which after baking and resisting the action of the metal leave carbonaceous residues. In comparing the answers to question No. 5 with Nos. 1 and 2, I find that in almost every case the amount of sand disposed of equals the amount of new core sand used, plus varying percentages of the molding sand used. Thus it would seem that in most foundries where dry sand cores are used, no effort is made to re-use the burnt core sand, but that it all is disposed of as waste material. There are some exceptions to this, however, in special classes of work such as car wheels where as high as 50 per cent of the sand as removed from the cleaning room floor is used in the new core mixtures. In several cases the old molding sand is treated for re-use. It will be recalled that at the convention of this Association last year a method was presented for our consideration by Messrs. Sanders and Hanley. (Vol. 24 Trans. American Foundrymen's Ass'n.)

Referring again to question No. 6, it was found that with one or two exceptions the burnt sand was either loaded in freight cars or hauled away in wagons to some dumping ground, the cost of disposal varying from 30 cents per ton to $1.50 per ton. Two or three replies from larger foundries stated a cost of $24 per day to dispose of their burnt sand. While it is doubtless true that sand is the cheapest material which enters into the cost of the manufacture of castings, we find the cost of handling and disposing of it adds to its original cost as much as 100 per cent. This factor depends largely upon whether the sand is handled by mechanical means or hand labor; upon the situation of the foundry relative to dumping grounds, the latter condition in some cases of foundries located in large cities being a serious one; and also upon railroad facilities.

Burnt Sand in Concrete

As exceptions to the rule we find one foundry disposes of some of its waste sand as a filler for a fertilizer; another of our members writes that they have used some of their refuse sand for concrete mixtures. It is interesting to note a portion

of their experience: "We have used our burnt sand for putting in foundations for machinery, and we find that it serves the purpose very nicely, and in places where we have previously been employed this burnt sand has been used in making cement floors, and these floors gave good service. We even used this burnt sand and burnt core sand in making concrete walls for a building, and the only bad effect that could be seen was that the flour in the cores made the walls flake. This flaking continued for a period of at least one or two years after the structure was completed and was very noticeable, especially after a continued wet spell. The flour which was mixed in this burnt sand was evidently not thoroughly saturated with moisture when the concrete was poured and upon long exposure to damp weather, it swelled sufficiently to flake off patches of concrete. In some cases only small parts the size of a dime, and in other cases large patches the size of two hands came off."

The answers to question No. 8 verify what has been said above to the effect that many make no attempt to re-use either the burnt core or molding sand; a few treat a portion of the burnt molding sand for re-use; and with one or two exceptions the used core sand is entirely discarded.

In answer to question No. 9, many replies give no estimate; some state from 30 to 80 per cent of the original cost of the sand; whereas others give actual money values varying from 15c per ton to $1.50 per ton. Obviously the best way of estimating this is in a percentage of the original cost of the new sand, delivered.

Not an Impossibility

The task assigned the writer was to gather in as much data as possible from those who have attempted in some way to deal with this problem. That we are not attempting to deal with something impossible, I quote an excerpt from a letter I received from the head of a large foundry corporation.

"With great regret I must state that I am not at liberty at this particular time to discuss with you our experience in this direction. We have spent considerable time and money perfecting apparatus and developing a process for this purpose,

and it would not be proper to divulge the details at the present time. I might add, however, that it is absolutely possible, at a very nominal expense, to take refuse sand and convert it back to a condition fit for use, in fact it is almost impossible to tell the old from the new. There are certain theories in sand reclaiming that we have conclusively demonstrated to our own satisfaction and when we have secured proper protection we will be glad to issue the facts for publication."

The personal experience of the writer has been, in attempting to use burned sand in new core sand mixtures that the cores are weak, soft, require an excessive amount of binder, and do not resist the action of the metal well. Even after burned sand has been washed and cleaned, if examined under the microscope it will be found that the individual grains are coated with a black carbonaceous residue. These absorb an excessive amount of binder and where seacoal has been used either in facing sand or in the core sand mixture, this has been coked and it is impossible from our experience to wash it all out. It must also be borne in mind that nearly all foundry sands contain a small amount of alkalis which are inimical to oil binders.

Henry M. Lane, consulting engineer, Detroit, about two years ago was employed by a number of Detroit manufacturers to experiment in washing and cleaning the refuse sand from their shops. I have asked Mr. Lane to submit a summary of his experiences in dealing with this refuse material. His paper is appended. I may also add that the writer has induced the Bureau of Mines to make a preliminary study of the possibilities involved in reclaiming waste foundry sand, at a cost sufficiently low to be practicable. Should their findings indicate favorable results I have been assured by the Director that they will co-operate with us in every way they possibly can in working out a practical method.

Waste Foundry Sand

By H. M. Lane, Detroit

In the past 20 years many attempts have been made to reclaim foundry sand. The principles covered in these experiments varied greatly, and the ultimate object sought also varied greatly. A process that is successful with steel foundry sand might fail utterly with brass foundry or aluminum foundry sand, owing to radical differences in characteristics of different materials. Steel foundry sand should be made up from pure silica sand, the grains of which are rounded rather than angular. This sand should then be bonded with a sufficient amount of refractory fire clay, so that it will hold its shape when rammed into the mold. All sand is damp, or as it is termed "green", when rammed in the mold. The bond must remain active whether the mold is poured when in the green state or is baked or skin dried. The percentage of fire clay used in such a mix is relatively small and the so-called wearing out of the sand is due mainly to the stopping of the fine passages by small grains, resulting in the breaking up of the larger grains under heat, and from dry or burned bond material.

Another interesting fact is that the mass law of chemistry influences very largely the temperature at which a given size of grains will start to melt or burn into the castings. Very fine sand will burn into a steel casting several degrees lower than coarse sand, and hence in this type of work we encounter the necessity of freeing the sand from these small and particularly angular grains.

For such work a cleaning process that will remove the burnt clay and the fine sand dust is what is necessary. This may be accomplished by washing or dry cleaning.

Dry Cleaning Sand

For dry cleaning a number of systems have been devised, and some patents taken out. One system that has been used in the west, treats the sand with high pressure air in such

a way as to cause the grains to impinge one upon another, giving a sand blast action which cuts off any adhering clay, scouring the grains. The system is then arranged to take away the fine dust and leave relatively clean grains. Other systems simply pass the sand through an apparatus which exhausts the finer dust without any attempt to give the sand a thorough scouring.

In this commercial world of ours, the process which will produce a product, just good enough for us to use, at the lowest cost, is the one that will ultimately be used, even if other systems may give a better though more expensive product. In steel foundry practice the ultimate factor is the cost of a ton of finished castings, and a process which recovers, let us say, 80 per cent of the sand in a fairly usable condition may be better than the one which recovers 90 per cent in a better condition but at a higher cost.

When we jump to the opposite extreme and try to clean or reclaim the exceedingly fine brass or aluminum molding sand we encounter a much more serious problem, and one which I hardly think is worth while attempting. It is, however, advantageous to clean the core sand. The statements thus far made have been with reference to molding sand. In steel foundry practice the core sand used is very similar to the molding sand and can always be cleaned to advantage. In the experiments which we ran we were convinced that at least 80 per cent of all waste sand material shipped out of the ordinary foundry can be recovered for re-use in some form. In the case of heavy gray iron work it can be dry cleaned, rebonded with proper kind of clay, and used as heavy work molding sand. In the case of aluminum and brass work the general run of sand from the foundry can be cleaned and used in core work with resin or water soluble binders. It, however, does not work well with oil. For the thorough cleaning of certain classes of sand, the wet process seems to be the best, but this necessitates first a scrubbing and then a washing, and takes quite a complicated plant, though the actual cost of cleaning per ton is low.

The foundryman is not interested in ultra or scientific processes, but is interested in the production of castings at a reasonable cost, and to accomplish this the simplest sand cleaning method available is what he wants. In some cases passing the sand over a series of sieves which will first take out the coarse waste material, and which will next remove the fine or dust material has been found to give a good product for rebonding for use in foundry work for a considerable line of gray iron castings. Each case, however, must be studied on its own merits, and local influences caused by the different grades of core and molding sand used have an important bearing on the subject. If I were running my own foundry I should certainly be prepared to clean the sand.

Discussion

THE CHAIRMAN, R. A. BULL.—Gentlemen, this is a tremendously important subject, particularly to those whose foundries are not located very close to a suitable sand bank. I remember not very long ago getting a letter from a steel foundryman in the state of Washington who was getting his sand from Illinois. Sand reclamation to that man was a very important subject. We would be glad to have a few words on this paper.

DR. RICHARD MOLDENKE.—I used to pay $1.40 a ton for my sand; if I had to pay $1.50 a ton to send the refuse away, it would have meant $2.90, apart from labor cost. If you will compare the tonnage of sand used to that of castings produced, and this may vary from 1 to 16 down to 1 to 4, you will find that the sand becomes a very serious item in the total cost; consequently, this question is a very important one. I think the bonding strength of molding sands will have something to do with a development which seems to be going on in the country, looking toward getting rid of seacoal completely in the foundry, as it weakens the bond though allowing the iron to lay against the sand nicely. I would therefore suggest that we study the question of the finish of the surface

of the mold instead of using facing sand and sea-coal. If you can give a mold the proper finish by coating it with graphite having the proper binder to make it stick to the mold, then you will do something which will help to make waste sand possible of reclamation as the carbonaceous matter complained of will be absent. I think we will come, finally, to the making of artificial molding sand, which will be practically "fool-proof"—a sand we can do anything with. The Bureau of Standards is at work on this now. I second Mr. Swan's suggestion that the American Foundrymen's Association appoint a committee to look into the question of sand reclamation in connection with the proper department of the government, and I am sure you will arrive at something of great value to the foundry industry.

THE CHAIRMAN.—We have a committee, as you know, advisory to the Bureau of Standards, and a brief comment on their joint work has been made in the next paper, which is simply a short report on Molding Sand Composition, by Director Stratton, of the Bureau of Standards.

MR. A. B. ROOT.—Before we leave the subject, I hope there will be a little more discussion on the paper we had last year by Mr. Saunders on the actual application of these methods, and I for one have found that in my work the application of Mr. Saunders' methods has been of very great assistance to anyone interested in sand problems. I had a very brief talk yesterday with one of the gentlemen exhibiting a certain sand machine. He says that he has some 60 sand mullers in operation. Now, to me, that is an indication that there is work going on in the reclamation of foundry sand, and I should like very much to hear something from some of the men who happen to be from concerns using those mullers. We have someone here from our company who perhaps can tell us something from his experience. I hope someone will tell us something about it; it will be too bad to wait for another year to hear something more.

DR. RICHARD MOLDENKE.—I wish to call attention to the fact that the reclaiming of waste sand is an entirely different problem from standardizing molding sand, and hence it would not fall within the province of the present committee.

THE CHAIRMAN.—That is true, unless the Association should delegate to the present committee authority to investigate along the other line. We would be glad to have someone take advantage of Mr. Root's suggestion to report on what has been done during the last year.

MR. H. B. SWAN.—I note, in the written paper, that one concern which controls a large number of foundries throughout the country, claims to be reclaiming all of its sand, and it states that it is obtaining patents on this process. I was unable to get any details regarding it, but it seems that when their process is covered they will be glad to make all details public. That has to do with core sand as well as molding sand. They claim to make it almost as good as the new sand; in fact, they say it is hard to distinguish it from the new sand.

MR. R. F. HARRINGTON.—Mr. Root has suggested that, perhaps, it would be of interest to the members present to know of the work that the speaker has personally observed along these lines. If you will remember, the keynote of the talk last year on the reclaiming of molding sands was relative to the proper method and machines which could best be employed to blend and mix the sand. It was generally conceded that the muller type of machine was best suited for this work. During the past year it has been my privilege to do considerable experimenting with the muller along these lines and the outcome has been the purchase of a muller for permanent use. The muller was applied in both dry and green sand work and I find that it makes the new material added far more efficient. Following a suggestion of Dr. Moldenke's some three years ago, we have to some extent replaced our new sand with a very high-bonded clay.

Those of you who were present at the convention in Atlantic City will remember from Mr. Saunders' paper that he had experimented along these lines with a very light grade of castings and with considerable success. The class of work, however, is somewhat different from that to which I am about to refer. In a shop melting 80 to 100 tons per day with a class of work 80 per cent of which is a machined surface, with new sands costing approximately $3.50 per ton, f. o. b. the plant,

and with dumping charges at about 50 cents per ton, the molding sand item becomes quite a problem. I am only just delving into the subject, but I have thought that perhaps a few rough figures might be of interest. The mixture for facing sand in one part of the shop formerly consisted of 50 per cent new sand and seacoal, the remaining sand being a waste product from another heap. The new mixture which has replaced the old to a large extent is made in the muller with the use of a high bonded Jersey clay and is approximately $1.75 per ton cheaper than the old mixture, a small amount of clay having entirely replaced the new sand; 20 tons of this facing being required daily, one can easily realize the saving. The foregoing was a green sand mixture.

A dry sand mixture for certain cores originally consisting of new molding sand, beer and flour, costing $1.40 per ton, is now made at a total cost for material of 35 cents per ton, the new material being a small per cent of clay and waste tailings of Jersey sand and Millville gravel which have failed to come through the riddles from other mixtures and which formerly went to waste. The muller thoroughly blends the clay and rich loam which surrounds the waste tailings with the old sand, thus producing a satisfactory core sand at a very small cost. No flour or beer was required in this core mixture, much to the surprise of our core department.

A foundry endeavoring to use a clay and old sand mixture in this way must guard against certain points or trouble will inevitably follow. I have found, for instance, in green sand work that the mulled sand must be worked a little drier, also that one must occasionally add an opener, for example Millville gravel or fire sand, in order to maintain the proper texture and avoid defects due to the closeness of the mixture. I suggest, in closing, that if interested in the reclaiming of your sand, you investigate the application of the muller for your own shops. I am certain from my own experiences that it is by far the most efficient machine for mixing sand and that the possibility of saving is well worth the attention of every foundryman.

THE CHAIRMAN.—Are there any further remarks on this question? I don't know that there is anybody here from the

Bureau of Mines, but Mr. Karr, who is connected with the Bureau of Standards, is present, and it would be helpful to have his ideas as to the best way to secure this governmental co-operation.

Mr. C. P. Karr.—At a suggestion made by the committee appointed by the American Foundrymen's Association, a discussion was taken up as to what constitutes good molding sand, and then it was advised that we attempt to obtain artificial molding sand, and the suggestion was made that a silica sand of very fine, rounded grain should be selected to make the first experiment with. The sand chosen was Ottawa mine run sand and that was separated into three different parts suitable for fine, coarse and medium castings, and the clay selected happened to be an Illinois fire clay. Now these sands were divided into three parts, what we call here No. 1 sand, which was retained on a 30-mesh sieve; No. 2 was the sand passing a 40-mesh sieve, and No. 3 was what was retained on a 40-mesh sieve. Fifteen per cent of Illinois clay was added to the body of this silica sand in every case, and some transverse strength tests were made. For instance, take the sand in which 7.4 per cent of water was used, which is about 40 c. c. of water to 500 c. c. of sand, the whole thing being determined by volume.

It shows that sand No. 2, passing the 40-mesh sieve, was very much stronger than the other; that is, they had a breaking load of 6.42 pounds per square inch on the No. 1 sand, and so it goes all the way through. In order to make this thing more interesting in comparison with sands which you have all used, the comparison was made with old tub sand which had been used for three or four years, and also with new Albany sand No. 2 which had never been used, and it was found in all cases that this artificial sand surpassed either the old tub sand or the No. 2 Albany sand. There was not sufficient time to extend the comparison further on to the sand retained on No. 40 mesh sieve, marked No. 3. Also the permeability sand test showed that the artificial sand was superior to the old or new tub sand. An interesting thing about this artificial sand, a combination of fine and coarse, was the melting point which was found to reach 1,500 degrees Cent. You steel men

are looking for sand which is very refractory. We have had a great many questions come up to the Bureau from the different departments of the government, the Panama Canal Commission and others, in reference to what constitutes a good steel facing sand, and in making this statement I am not speaking officially, and I want to put it up to all of you to have you either confirm or deny it. If you can confirm it, I will be very happy to have you say so, and if you can offer any experience which is contradictory to this statement, I will be equally glad to have you say so, because what we want to know is the truth and nothing but the truth. The statement I made, after careful examination of these samples of sand sent up to us by the Panama Canal Commission, was that for a steel facing sand the specifications should require that the melting point should not fall much below 10 degrees plus or minus 1,650 degrees Cent. I would like to have you think of that proposition. You know that pure iron melts at 1,550 degrees Cent.; steel at somewhat less, but you all know that the pouring temperature of steel is considerably greater than its melting point, and I contend that the safest criterion you can have on a sand or clay used as a binder for steel or non-ferrous metals is its melting point, and what I should like to have you do, if you agree with me, is to have you say that you think so, so that it will be the consensus of the opinion of the American Foundrymen's Association that a melting point test ought to be asked for when you are asked to make a decision upon some new unknown molding sand. I have specimens here of the mechanical analysis of this artificial sand and the mechanical analysis is all shown in those bottles in which there are corks. The sand itself before separation, but separated into three different types, can be found in these little bottles with the metal stoppers, and if any of you are interested, I would be glad to have you come and look at them, also to have your opinions about this melting point test.

The Chairman.—What is your idea about the best way for us to get governmental co-operation on this question of the reclamation of old sand?

Mr. C. P. Karr.—I think the president of the American Foundrymen's Association should appoint a committee to confer

with both the Bureau of Standards and the Bureau of Mines. I am speaking *ex parte* on this matter. The Bureau of Mines is interested in sands from the mineralogical point of view; the Bureau of Standards is considering these sands from the standpoint of their physical tests which you all will want to use to determine what kind shall pass for your purpose.

Dr. Richard Moldenke.—I think that the Bureau of Mines would be the best to take up the question of the disposal of sands and the Bureau of Standards would be the best to take up the question of the tests of sand. I think it would be well to have two committees. That 1,650 degrees Cent. translated into our language, is 2,700 degrees Fahr., and you see 2,900 degrees would be quite outside the melting point of iron; so it would be well to make that limit 2,700 degrees. These sands are natural sand changed to artificial sand by the addition of clay as given by Mr. Harrington; it is in line with progress, so I think that fits it the way you want it.

Mr. C. P. Karr.—I meant to say that the bonding test suggested by the committee has not been made yet because I did not have time enough to get the samples into Mr. Saunders' hands, but it is intended that the bonding test, as suggested by your committee, shall be made, and Mr. Saunders expressed his willingness to co-operate with us and we are to conduct the bonding tests simultaneously and hope to have them all finished and report to you next year. While this clay was Illinois fire clay, if any of you know of clay which has a higher refractory test, we would be glad to duplicate those experiments to see whether we have secured the best clay for that purpose, but this Illinois fire clay does produce very good results.

The Chairman.—From what district in Illinois does it come?

Mr. C. P. Karr.—I do not know just where it came from.

The Chairman.—What is the sense of the convention on the suggestion of co-operation? I think it would be best to appoint a committee to co-operate with the Bureau of Mines on the reclamation of foundry sand, while letting our committee on molding sand continue its work with the Bureau of Standards. The chair will entertain a motion to that effect.

Dr. Richard Moldenke.—I will make that motion, that we appoint such a committee, but I hope you will not put me on that committee, because I am on the other committee. I move that we appoint a committee to co-operate with the Bureau of Mines on the reclamation of waste foundry sand.

The motion was seconded and adopted.

The Chairman.—This very brief report over the signature of Dr. Stratton, of the Bureau of Standards, on molding sands, is next on our program.

Mr. C. P. Karr.—I have just given that.

The Chairman.—I was just going to say that the substance of that report has been incorporated in Mr. Karr's remarks. Is there any further discussion?

Mr. S. G. Flagg III.—Ten years ago, in Paris, I had opportunity of seeing a machine of the same type as the machine these gentlemen have mentioned. Abroad, for a great many years, having had no natural molding sand, it has been made by combining silica and clay. I saw this machine in operation, and it was turning out good molding sand. My company bought one of these machines and brought it to this country and operated it for a long time, but had difficulty in getting labor intelligent enough to put the sand in at the right degree of moisture and finally abandoned it. With reference to reclaiming molding sand, we have gone into it pretty thoroughly and have found—of course this depends largely on the class of work—on our work our reclaiming cost is over $2.50 a ton, so we have no use for the kind of reclaiming mentioned. But by using a centrifugal mixer, you can take your burnt sand and turn out a very good grade of molding sand. In regard to core sand, we find it a matter of a very different nature. In the use of an oil binder we have found that no matter whether you wash your refuse core sand or take your gangway sand and wash it, it is simply a matter of using more oil with your reclaimed sand than with your new sand. If you are mixing 30 or 40 or 50 to 1 with sharp silica sand and substitute reclaimed sand, you increase the amount of oil binder almost directly in proportion as you increase the amount of reclaimed sand.

Suggested Standard for Pattern Parts

By W. W. Carlson, Manhattan, Kas.

The basis of successful, competitive manufacturing today rests to a great extent upon the proper consideration of many things which a few years ago were scarcely noticed at all. This is due to changes in methods of production, as well as improvement in the methods of transportation and communication. All three of these have had a wonderful effect upon our industrial life. The changes in methods of production are perhaps due to a large extent to the effect of changes in methods of transportation and communication. The early manufacturer's product supplied only the immediate neighborhood and was controlled by circumstances in that community only. Competition was light and was governed by the same conditions. Today transportation and lines of communication have reached such a degree of perfection that each individual manufacturer is practically in competition with the whole world.

It is this wonderful change, that has taken place in the past 50 years, which is fast gaining momentum, that will eventually almost completely reconstruct our whole industrial life.

Today we see associations of individuals in practically every walk of life. These will be constructive or destructive depending upon the attitude of the individuals composing the group. It is gratifying to note that the constructive groups are very much in the majority. They are capable of a wonderful service to mankind and it is hoped that they may steadily increase in number and power.

Groups of men like those making up the American Foundrymen's Association can do a wonderful amount of good by getting together, meeting their fellow-men whose interests are very similar, exchanging ideas and discussing and

solving various problems as they come up in connection with their life work. The atmosphere is inspiring and uplifting in many ways and the results of the meetings of the association should be of such a nature as to have this same influence, possibly of varying degree, to the many who do not have the opportunity to attend. Anything that can be done to make their work easier, more profitable, or to give it an increasing interest would be very commendable.

There are many factors that influence and greatly affect our industrial conditions. It is the idea of this paper to touch only upon two of these and put emphasis largely upon one. These are (1) specialization, and (2) standardization.

Specialization has reference to the proper selection of the most suitable machine or man for the particular work to be done. Standardization has reference to the detailed methods employed in the utilization of this highly efficient skill.

No one questions the advisability of using highly specialized machinery in the production of duplicate parts. Neither is there any great difference of opinion as to the profitableness of highly specialized human skill in any line of endeavor.

Many people, however, cannot readily reconcile themselves to the adoption of certain standards or of methodically doing certain parts of their work, which may have been reduced to a science by someone who has made a special study of the problem. The tremendous rate at which human experience is being recorded is certain to still further accelerate specialization in human endeavor and reduce to standards many of the things that are now done "every man according to his way." One of the objects in scientific research should be to reduce to definite standards the results of human experience. Only in this "relay system" of working out our problem, that is where each one records intelligently the results of his life work so that his followers may start where he left off, will we ever be able to accomplish very much toward the solution of the infinite number of problems which the human race has to work out.

This concentrated attention considered along the engineering line is productive of highly specialized machinery that takes on the skill of the concentrated attention given it. In some cases this machinery is so effective as to displace many workers. To these it may be a temporary hardship, although to humanity as a whole it is a benefit. The consideration of the masses is of far more importance than the individual and we must concede the justification for the trend along this line.

Creditable as are the results of specialization, they are considerably below par unless particular attention is paid to systematic methods employed in carrying out proposed schemes. Standardization along every line should be more strongly emphasized in order that much of the useless expenditure of human effort may be eliminated, and this energy used for the betterment of man.

The industrial world in the United States today is in the midst of a great turmoil in which details are by far too large an extent turned over to the inexperienced or left to the office boy to work out. As boys we were taught, "to look out for the pennies and the dollar would take care of itself," or, "a stitch in time saves nine." This advice is good. It is the attention to the details that counts and it is the purpose of this paper to bring to the notice of able men, some of the details in connection with foundry and pattern work which the author believes need attention, if the best results are to be obtained from the energy and time spent.

There has been a marked change in the attitude of those in authority towards the smaller things in factories. A few years ago the proprietor cared practically nothing what the employe did outside of working hours just so long as he appeared at his place of work on time. The expenses of reading rooms, gymnasiums, well lighted rooms, lunch rooms, etc., were considered unjustified, or a donation that would net no creditable returns. This can also be said about cost keeping systems a few years ago. Now we find that conditions are changing as competition becomes more severe, and only the man who knows his costs and has systematized his

methods so that his costs are low is able to meet keen competition and survive when others fail.

We have long known that a properly fed and cared-for horse is more productive than one improperly taken care of, but we have been slow to realize this in connection with our own condition. We like to work with good tools and under well organized systems and since we like it we will take more interest and do better work.

The author in making the following suggestions does so without soliciting any personal credit, and without criticising other systems which have been worked out for the same purpose. It is only hoped that the suggestions contained herein may be the means of concentrating, more efficiently, the ability of the men in this line of work, so that their work may be made easier and more satisfactory.

The system of coloring the various parts of a pattern as they are made has been used for some time by many concerns, and has proved very valuable to the people who have to use the pattern. We all know that the slag, dirt, and other impurities in the metal poured, have a tendency to rise to the top of the mold and here we may usually expect to find more or less imperfections in the casting. If the molder knows what parts are to be machined he can in a good many cases adjust his work without hindrance and so mold the piece that the finished part will be down at the bottom of the mold, with the chances for a good metal in the machined surface increased.

It is not necessary to mention the advantages of definitely colored core prints, though to some this may seem of little importance. The same might be said of coloring of that portion of the pattern which makes the unfinished part of the casting, or that portion upon which another fits.

The colors used and recommended by the writer are as follows:

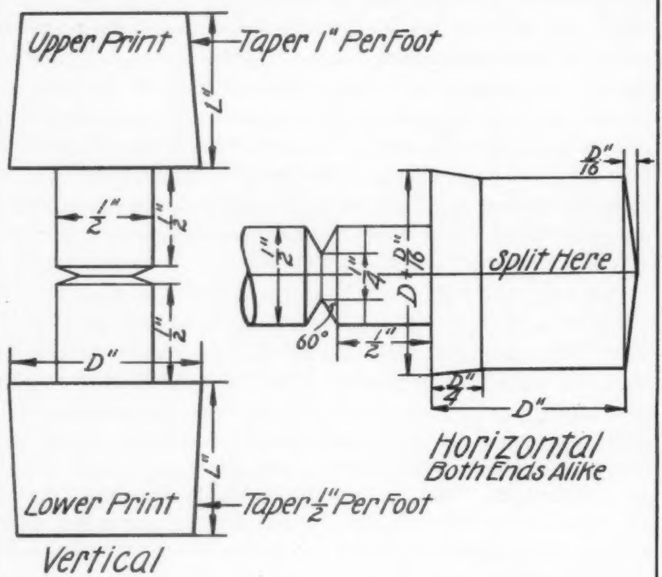
Rough casting	Yellow
Machined surfaces	Red
Core prints	Black
Pattern joints	Natural shellac
Pattern boards	Black

The colors, yellow and red are those recommended by the American Society for Testing Materials for steel castings. Another color was found to be needed to show where parts fit together. Black is used for all parts of patterns, boards or fixtures which may be attached to the patterns but are not to be a part of the casting. These colors may not be ideal but they fill the purpose admirably. In a modified form they are already in use by steel manufacturers, and it would seem to be a very easy matter to settle on some one plan that would soon become generally used throughout the country.

The objection that is sometimes put forth against color schemes is that they add to the expense, some think needlessly, yet every pattern worthy of the name should be properly coated to protect it. The expense of this coating is a small per cent of the total cost of the pattern. The additional expense of the added colors is very slight and fades completely from view when the advantages gained are considered. There is another advantage in the addition of pigments to the casting and that is the increased durability of the paint or varnish.

A standard system of core prints has been adopted in the shops of the Kansas State College. It works out very satisfactorily as a turning exercise for the engineering students besides providing a stock of prints handy for patterns when needed, either for regular work, rush orders or emergencies.

As will be noted, the vertical core prints have different tapers for the upper and lower ends. This taper is found to be sufficient but not excessive, and it is believed it will fit all average conditions. The shanks are all turned to the same diameters so that certain prints can be removed and others substituted of whatever size is desired. The commendable points that these prints have are as follows: (1) There is a saving of time in making patterns by having core prints on hand. (2) There is a decrease in expense due to the fact that apprentice boys or cheap help can be used instead of the more highly paid patternmakers. (3) Ease of changing the size of core prints on a pattern for pulleys and



D	L	D	L
3/8"	5/8"	1 7/8"	1 1/2"
1/2"	5/8"	2"	1 1/2"
5/8"	5/8"	2 1/8"	1 1/2"
3/4"	7/8"	2 1/4"	1 1/2"
7/8"	7/8"	2 3/8"	1 1/2"
1"	7/8"	2 1/2"	1 1/2"
1 1/8"	1 1/8"	2 5/8"	1 1/2"
1 1/4"	1 1/8"	2 3/4"	1 1/2"
1 3/8"	1 1/8"	2 7/8"	1 1/2"
1 1/2"	1 1/4"	3"	1 1/2"
1 5/8"	1 1/4"	3 1/8"	1 1/2"
1 3/4"	1 1/4"	3 1/4"	1 1/2"

SUGGESTED STANDARD FOR CORE PRINTS

in various places where varying holes are required, is of value. (4) Since the tapers on the vertical prints are the same it is much easier and surer to secure properly fitted cores in the core prints. (5) As will be noted, the horizontal print has an increased diameter next to the pattern to aid in avoiding crushing the sand next to the mold when the core is put into place. (6) Last but not least, there results an increased rate of production and satisfaction to the workman by having definite written instructions for the men to follow.

It is not claimed that this is any great and radical change from other systems, but it is hoped that this system has enough good points to receive favorable attention by the association, or that a combination of this and others may lead to the adoption of some standard. It also is hoped that this system, and others, may arouse enough interest and discussion to eventually lead to the adoption of something really worth while.

The accompanying standard lists prints only up to 3¼ inches in diameter with a length of 1½ inches. It is considered that this length prevail up to 4 inches where the length changes to 2 inches, this continues to 6 inches where the length becomes 3 inches, this continuing to 8 inches where the length becomes 4 inches. Special cases will probably demand a change, but the above, it is believed, will answer all ordinary conditions as usually found in the shop.

The question of a standard report sheet for heats in the foundry might well be considered and a form decided on that would be applicable for all foundries. The question of draft is another upon which action might also be taken, as we all know that excessive draft on a part that has to be machined means a loss in the machine shop, and that a lack of sufficient draft causes a loss and delay in the foundry. There are many other things that I believe could be worked out by an association of this character that would make for uniformity and consequently easier work for the trade.

Semi-Steel

By David McLain, Milwaukee, Wis.

While it is true that semi-steel has not been recognized in iron and steel nomenclature, still, as it ranks among the most valuable products of the gray iron foundry, it should be accorded proper recognition and standard chemical specifications covering the different classes of castings should be clearly defined. I will admit it is rather unfortunate that any cast metal containing from 3 to 10 per cent steel is designated as semi-steel, and in this particular we are in hearty agreement with those who consider that semi-steel is a misnomer.

Our contention always has been that no metal could be defined as semi-steel unless it contained from 25 to 50 per cent steel, and even the reputation of this metal has suffered to some extent from those who offer a product as semi-steel which is not even a good gray iron.

Any man who thinks he can simply throw some steel scrap in with pig iron and make good semi-steel is very much mistaken, but such is the custom in a large number of shops, and those are the ones that claim they are "putting it over" on the machine shop men who pay for good semi-steel, but don't get it.

Foundrymen Have Been Thinking

Although there have been large casting losses in the past by those who knew but little of the science of melting steel in cupola mixtures, still I believe the literature and papers published on semi-steel during the past few years have started many foundrymen thinking along right lines.

More than 1,000,000 tons of semi-steel were made last year and every foundryman sooner or later must be able to make real semi-steel as engineers are continually demanding stronger metal, and lighter sections for castings that must stand higher tests.

Every industry has its science. Up-to-date foundry practice is no longer guess work—it is a science. But science does not replace common sense, and in an industry like ours there can be no set rules that will cover the operations or the operators in the manufacture of every grade of castings. We need men with common sense to fit proven scientific facts to their individual requirements and local conditions.

My claims and teachings are all based on facts. My experience in the foundry covers thirty-five years as molder, foreman, superintendent and manager, during which time I operated gray iron, crucible, converter and open hearth plants. This experience together with the work of systematizing foundries gave the writer a varied knowledge of cupola and steel furnaces.

Historical Facts

The aim of this discussion on semi-steel is to place before the members of this association and the foundry trade in general, a few plain truths about semi-steel. Many of these statements deal with historical facts dating back 15 years. Many points set forth herein may be opposed, and even ridiculed.

For 50 years or more, foundrymen have added steel to iron in the ladle, while comparatively few melted slight amounts of steel in the cupola, but up to 1902 or 1903 I could find no record of any man having used large percentages of steel in castings of light section.

Years ago I brought foundrymen from their own shops to see the steel charged in the cupola in a converter steel plant. They actually saw the steel charged. They saw the metal coming from the cupola and yet remarked: "That is all right, McLain, you may be able to do this in the steel foundry, but you never could do it in the iron foundry."

In 1899, A. Christensen, the well-known inventor of the street railway air-brake, built a foundry to make gray iron, steel and brass castings, of which plant I was superintendent for 5½ years.

A Difficult Casting

One pattern in particular, a cylinder head, had proved very difficult as the walls were only 5/16-inch section, while they were hydraulically tested to 200 pounds per square inch.

In those days other engineers allowed one inch and more section for 200 pounds pressure, but Mr. Christensen saw the light in advance. It was a great advantage to the mechanical world that he did, as it was only a few years later that the automobile industry started in earnest. Today, it is truly wonderful when it is known that some cylinders only 5/32-inch section are being made with 10 to 20 per cent steel and tested to 200 pounds.

At that time the losses on the cylinder head castings were exceedingly heavy, so much so, that every foundry making them sustained large financial reverses, distressing both to the foundrymen and to Mr. Christensen's company. Investigation proved that almost every conceivable known mixture had been tried out in various states, other than Wisconsin, by foundrymen having good reputations on this class of work. It was a serious matter for Mr. Christensen and his associates, as they had large orders for air-brakes but were unable to secure satisfactory castings.

This was the situation when I was engaged. After a long series of experiments, it was finally decided to drop gray iron and turn our attention to the use of steel scrap. We sought expert advice and personal service from those successful in using steel in heavy sections. After 10 weeks' experimenting the experts finally claimed the section should be increased, but Mr. Christensen would not accede to their wishes. Foundrymen advised that the pattern should be changed, but he would not listen to it, as he claimed: "When the metal was right, the castings were good." Later developments proved that he was correct.

From the start I believed that steel scrap in the mixture would enable us to close the grain of the metal, but the great danger was that the metal would be too low in carbon, as all leading authorities claimed that "steel reduces carbon". Now as carbon must be high if sections are thin, apparently steel was not the right material to use, unless it was possible to absorb carbon from the fuel.

A Few Theories Exploded

All textbooks, whether by technical or practical men, maintained that steel reduced carbon, that it was not a good thing to

use as it caused "hard spots", that "a higher melting temperature was necessary," etc. Even today, my claim that steel melts first puzzles some chemists, metallurgists and others, who evidently do not take into consideration that steel has a great affinity for the elements and absorbs a large quantity of carbon from the fuel.

Those familiar with laboratory experiments know that if steel is added to gray iron mixtures, and melted in a crucible, the total carbon will be reduced. They also know that when steel alone is melted in a crucible it requires a higher temperature to melt it than the mixture of steel and gray iron. When steel is mixed with gray iron and melted ***in a crucible*** a slight loss will occur by oxidation and the carbon will increase somewhat, due to the absorption of this element from the pot.

The total carbon, as calculated, in the iron will remain practically the same, but as the steel content of the mixture will add to the total weight of the resultant metal without a corresponding gain in carbon, the total carbon of course will be less than if all iron had been used. That condition, however, does not exist when melting steel scientifically in the cupola.

If steel only, is melted in a crucible, the chemist is quite right in his contention that steel requires a higher temperature than gray iron, but the same conditions are not met with in melting iron or steel in a cupola.

Carbon Absorbed From Fuel

When melting steel with cupola mixtures, high carbon coke is used for fuel. Coke, of course, also can be used in crucible melting, but in this practice the metal does not come in contact with the fuel and therefore it does not absorb carbon from it. On the other hand, steel melted in the cupola comes in intimate contact with the fuel and owing to the very low percentages of the different elements in the steel, it has a strong affinity for them, particularly carbon. Consequently when the steel is heated to redness, it begins to absorb carbon and when the steel and fuel both become incandescent, the steel becomes saturated with carbon. In this state it is not steel as we know it commercially, but it is a ***high carbon metal,*** and as the carbon

increases, the melting point of the steel decreases until the temperature at which it will melt is lower than the temperature of the cupola.

Now this result was not obtained simply by charging iron and steel scrap into the cupola, but was the result of much research work. When I first suggested to our melter that we try to melt steel in the cupola, he was horrified and endeavored to persuade me not to try it, as he claimed he had experience with it. He pointed out to me the harmful results following the use of only a few handfuls of steel and even went so far as to state a "spike in a piece of railroad tie" nearly spoiled a whole heat. Today, we know of firms who want to make semi-steel, and would if it were not for such stories.

Oxidizing Steel Scrap

Steel will not stand a cutting flame, but must be melted by a mild flame. The reason is quite simple. The carbon and silicon in steel are very low. The carbon ranges from 0.15 to 0.30 per cent in mild steel and the silicon about the same. When this metal has been heated and is about ready to melt, it will melt, naturally, as soon as it reaches the proper temperature, which should be obtained by a mild blast. But if high blast is used, the cutting or oxidizing flame will cause excessive oxidation.

Carbon, silicon and manganese are burned out of the pig in the converter process of making steel, and it is a very simple process until the metal is nearly free of the elements, then the operator must exercise the greatest caution in order to shut off the blast and turn down the vessel at the proper moment, for the metal at this time may be oxidized in a few minutes and the whole heat lost. When it is understood that during this process all graphitic carbon in the pig is converted to combined carbon in a few minutes by excessive blast, is it any wonder that the use of steel in cupola mixtures does not produce the best results? The traditions of cupola practice were thicker than the walls of the cupola itself and it was necessary to replace these traditions with proved facts.

Before we were through experimenting I had tried eight or ten different sized tuyeres until we learned that a 3½ to 4½ to 1 tuyere area was the best for that cupola when the proper amount of air was being delivered per minute.

Coke Savings

The false claim that more coke is required to melt steel than iron was made in those days, just as it is today, by some men not well versed in the fine points of the foundry business. Allowing that you are an expert melter of iron and steel, still the best metal, the real semi-steel, cannot be made unless you mix iron with brains and the proper percentages of the elements, particularly manganese, as this is very important.

To prove that less coke is required when melting steel, let me quote a few records made by progressive American foundrymen:

Daily tonnage	Melting ratio	Pounds coke required	Daily saving pounds	Yearly saving tons	Saved per year on coke at $5	$6	$7
5	6 to 1	1666					
	increase to 8 to 1	1250	416	62	$310	$372	$434
15	6 to 1	5000					
	increase to 9 to 1	3333	1667	250	$1250	$1500	$1750
30	7 to 1	8571					
	increase to 10 to 1	6000	2571	385	$1925	$2310	$2695

When melting 30 tons per day with coke at $6 per ton, and you increase your melting ratio from 7 to 1 to 10 to 1, you realize a saving of $2,310 per year, equal to interest at 6 per cent on $38,500. ***John D. Rockefeller overlooked the foundry business.***

Manganese is a Scavenger of Iron When Above 0.50 *Per Cent*

I knew the value of manganese in steel castings and wanted to use it for semi-steel castings—a higher manganese content than was found in the ordinary pig. I believed it should be melted in the cupola and I succeeded in doing it.

Iron, steel and manganese have a great affinity for sulphur, but as manganese has more of an affinity for oxygen than for iron, it has a tendency to leave the iron and will attract a percentage of sulphur, forming a manganese sulphide, some of which passes off in the slag. The amount of sulphur expelled from the metal will depend on the amount of manganese, the nature of the slag-forming elements, and the temperature at which the metal is melted. If both manganese and sulphur are high in the casting, have no fear of the sulphur, as it will be neutralized by the manganese.

At the time I began experimenting with semi-steel, it was generally believed that manganese hardened castings when above 0.85 per cent because of the accepted theory that manganese converts graphitic carbon to combined carbon. But as silicon converts combined carbon to graphitic carbon, it was not mentioned what the percentage of silicon was when manganese hardened iron.

It was impossible to secure any reliable data on the percentage of manganese which should be used and as our local blast furnace made no pig with more than 0.70 to 1.00 per cent manganese, I purchased a few tons of 80 per cent ferromanganese in lump form to add to the charge going into the cupola. The resultant metal enabled us to make those very same castings that Mr. Christensen desired so much, with only 1 to 3 per cent loss and our later experiments proved that steel scrap intelligently used was beneficial in all mixtures. Even 10 per cent increases the transverse strength of light castings from 25 to 35 per cent.

Thirty Per Cent Increased Strength With Ten Per Cent Steel

A concern in Michigan wanted stronger castings, but did not care to increase section nor weight, so under our guidance they began using waste steel clippings with an increase in strength with only 10 per cent steel. The gray iron analyzed as follows: Silicon, 2.30 to 2.50 per cent; sulphur, 0.08 to 0.09 per cent; phosphorus, 0.75 to 0.85 per cent; manganese, 0.30 to 0.50 per cent. With 10 per cent steel the metal con-

tained from 2.10 to 2.30 per cent silicon, 0.07 to 0.09 per cent sulphur, 0.60 to 0.70 per cent phosphorus and 0.55 to 0.70 per cent manganese.

The strength tests were as follows:

	Gray iron pounds	10 per cent steel pounds	Percentages in favor of 10 per cent steel
Average transverse strength...	2252	2900	28.7
Minimum transverse strength..	2180	2760	26.6
Maximum transverse strength..	2310	3020	30.7

Made in Same Cupola

Semi-steel is made in the same cupola with regular gray iron mixtures. No extra coke, special appliances, fluxes or new equipment are necessary. It is made in the same heat with other mixtures. It may be melted in the early part of a heat—in the middle or last part of your regular heat. Or you may begin with 30 to 40 per cent steel on the bed, run as much of this grade as is required and then follow with 20 to 25 per cent steel.

Steel scrap should never be added to a ladle of molten metal, as numerous tests have proved that many imperfections in castings are traceable to this practice. A higher temperature is obtained in the cupola than in the ladle and all gases are liberated in the cupola and go up the stack. This is not so when adding steel to the ladle, as the temperature of the metal is considerably reduced when steel or other cold material is added. Generally when steel is added to the ladle, these gases are liberated in the castings and we find hard spots, blow holes, etc. No more coke is required to melt semi-steel than gray iron. In fact, scientific melting has taught melters to bring down hot iron with less fuel than formerly although they are now using 20 to 50 per cent steel.

Strength and Reduction of Section

As it is 25 to 60 per cent stronger than gray iron, semi-steel may be of lighter section, hence it allows a reduction in weight by a reduction in section, making a big saving on metal. As a

slight addition of steel has a very noticeable effect on the strength of metal for light castings, this has led many to assume that if a larger amount of steel is used, the metal would replace malleable iron. This is a mistake, and competent investigators never have contended that unannealed semi-steel should replace light malleable castings.

Cupola Steel

Quite a few of our friends have written us lately inquiring about making steel in the cupola, but as there never was and never will be steel made in the cupola, using coke for fuel, a few words on this subject may not be amiss right now. While malleable iron formerly was melted in the cupola, the practice was discontinued when a better furnace was designed. This furnace is called the air furnace or open hearth.

Some foundrymen who are making cupola malleable iron used malleable pig iron and investigation proved that with a percentage of this pig, large amounts of the return and steel scrap could be melted and after being properly annealed, could be twisted and bent cold. A tensile strength of 55,000 to 65,000 pounds per square inch could be obtained. The metal is white before being annealed and as the annealing required from 10 days to two weeks, it was impossible to ship castings in less than three to five weeks from date of order.

This process is older than the hills and has been all but abandoned by those who formerly followed it, as it was a heart-breaking job at the best. The melting ratio was very low; the losses were very heavy; the long annealing period was very discouraging, and if it were not for the bending tests, good semi-steel is preferable. The buyers thought it was steel, although many steelmakers advised them it was not steel. In fact this material is really an annealed semi-steel.

Fakers for the past hundred years have fooled unsuspecting foundrymen, especially in small towns, by representing that they would revolutionize the foundry business by making steel in the common cupola. The worst feature of all is the fact

that these fakers lined their own pockets, jumped out of town over night, and sought new fields, while good honest people lost their hard-earned savings.

Success With Steel Castings

If you want to make steel castings, build a suitable furnace and equip your plant to make either crucible, converter, open hearth or electric steel. Each process has proved its worth in certain lines of castings. As the malleable producer got away from the cupola, to the air furnace, so has the steelmaker found the proper furnace for producing steel for his requirements.

Semi-steel is believed to be a great heat and acid resisting metal, because the metal is purer than gray iron. In recent fire tests of gray iron and semi-steel castings, to learn which is preferable, the gray iron lost 34 per cent by weight, while the semi-steel only lost 9 per cent. Even the despised grate bar is in a higher class than formerly, and railroads are eager for semi-steel grate bars, as tests have demonstrated that one set of semi-steel grate bars stands up better than three sets of gray iron bars.

Gears and gear blanks made of semi-steel frequently will outwear steel gears. The high graphitic carbon in semi-steel acts as a lubricant, a feature not possible in steel castings. Many concerns who formerly made all their gears of steel are now making them of semi-steel. Acid castings, air, gas, water and steam engine castings, ammonia fittings, crane wheels, cross heads, gears, gear blanks, grate bars, glass house molds, jig castings, lathe beds, locomotive parts, machinery castings, diesel engine parts and valves, are improved when 30 per cent steel or more is used.

That there has been a vast improvement in many foundries after they learned to make semi-steel, is very agreeably acknowledged by some of those who have suffered large financial losses, endeavoring to make gas engine, automobile and other cylinders of gray iron.

Microphotographs and Analyses of Samples

Fig. 21 is a micrograph of gray iron. You will note the large black carbon flakes. These flakes break up the structure

of the metal, thus making it brittle and weak. The gray substance is carbon, combined with iron, forming steel, while the white is iron. The analysis is as follows: Graphitic carbon, 3.15 per cent; combined carbon, 0.15 per cent; silicon, 1.85 per cent; sulphur, 0.098 per cent; phosphorus, 0.402 per cent; manganese, 0.50 per cent. Fig. 9 is a specimen from a small gas engine cylinder made of gray iron, that nearly put the maker out of business. The manager of the foundry did not believe in the use of steel, but when the firm became converted he graciously consented to follow instructions and in a few weeks the loss was reduced to 2 and 3 per cent as against 20 and 30 per cent previously.

Fig. 22 is a sample of semi-steel in which you will note the graphitic carbon flakes are exceedingly small. The gray constituent is steel and the small white particles are ferrite or iron.

The writer believes the following classifications, with analyses, have proved best by actual test for semi-steel castings: Automobile cylinders, pistons and other light castings, 3/16-inch to ⅜-inch section with 10 to 20 per cent steel; silicon, 1.90 to 2.25 per cent; sulphur, 0.07 to 0.1 per cent; phosphorus, 0.35 to 0.55 per cent; manganese, 0.65 to 1.00 per cent. Packing rings, gas engine cylinders and automobile cylinders, ⅜-inch to ⅝-inch sections, with 15 to 25 per cent steel, silicon, 1.65 to 2.00 per cent; sulphur, 0.07 to 0.1 per cent; phosphorus, 0.35 to 0.55 per cent; manganese, 0.65 to 1.00 per cent.

Fig. 2 is a micrograph of a specimen from a light gas engine piston. Figs. 8 and 11 are packing rings; Figs. 13, 16, 17 and 18 are cylinders; Fig. 14 is a gas and air mixer with 2.02 per cent manganese; Fig. 12 is a piece of chilled mold board, with 20 per cent steel; Fig. 3 is a specimen containing 30 per cent steel; Fig. 4 is a specimen containing 40 per cent steel; Fig. 7 is a specimen containing 30 per cent steel; Fig. 5 is a specimen containing 40 per cent steel; Fig. 15 is a specimen containing 50 per cent steel; Fig. 1 is a specimen containing 50 per cent steel; Fig. 20 is a specimen containing 40 per cent steel.

Projectiles of Semi-Steel

While both large and small projectiles are being made of semi-steel "somewhere on the continent" and quite a few places in America, still technical men will hardly credit this statement. Fig. 23 shows several 12-inch projectiles which weigh 1,200 pounds net, and 1,600 pounds gross. Thousands of these have been made in America. Fig. 24 shows the same projectiles with the risers turned off. They are shipped in this form and are finished by the purchaser. Fig. 25 shows a molding machine used in making small projectiles. The pattern, core and one-half of a mold may be seen.

Hardening Semi-Steel

An eastern firm objected to the high cost of the die steel used in its forge shop and someone suggested semi-steel. The foundry superintendent was called on and he agreed to make some semi-steel bars, which he thought could be hardened. They first tried it on a few punches for hot work, but it was either too soft or too hard, until they hit on the right process of hardening. The writer does not claim that semi-steel will replace tool steel, but is merely reciting a few facts, backed up by analyses and micrographs to show a few of the things that have been done with semi-steel. The concern just referred to has quit buying steel for making dies as semi-steel wears better, is easier to machine and is much cheaper. Fig. 4 is a micrograph of the die metal as it was originally cast in a bar or block 4 inches square by 20 inches long. The analysis is as follows: Combined carbon, 0.70 per cent; silicon, 1.45 per cent; sulphur, 0.092 per cent; phosphorus, 0.344 per cent; manganese, 0.81 per cent. The transverse strength is 3,800 pounds per square inch. This 4-inch bar was sawed in 1-inch square sections and turned down to ⅝-inch rounds for punches which have been working very satisfactorily.

Fig. 26 was made from an ordinary photograph of a punch that was soft and is remarkable in that it shows that semi-steel will stand quite a little bending without fracture. That is, of course, due to the smaller amount of graphitic carbon flakes. Figs. 27 and 28 are taken from a punch, Fig. 27 being the

unetched specimen in which the dark colored flakes are graphitic carbon, the white ground being a mixture of iron and steel. The principal thing to note about this micrograph is the small size and small quantity of graphitic carbon flakes as compared with regular cast iron.

Fig. 28 is taken from the same specimen but etched, so as to distinguish between the pearlite, which is steel, and the ferrite, which is iron. In this the white portions are ferrite, the rest steel. The black double lines are graphitic carbon particles. From this micrograph, the principal thing to be deduced is that the material is very nearly saturated with combined carbon, much more so than is usually found in regular gray iron. In other words, the material is practically a steel with small graphitic carbon flakes. Both of these micrographs are magnified 200 diameters.

Fig. 29 is taken from the edge of a semi-steel punch that has been carbonized and hardened. The white particles are known as cementite, which is an exceedingly hard, brittle substance composed of iron and carbon combined together in the proportion of three parts of iron to one of carbon. At the edge, where the general color is considerably darker, there is not much of this cementite, in fact, the material has become lower in carbon and, therefore, while equally as hard, is not so brittle. In carbonizing ordinary steel there is an addition of carbon to the outside surface of the steel. In this case the action has been the reverse as the long heating in the carbonizing material has reduced the total carbon, leaving practically a 0.90 per cent carbon steel edge. The graphitic carbon has been absorbed by the iron in the center of the punch which accounts for the large amount of cementite. The magnification is 25 diameters.

Fig. 30 is taken from a sample of a punch that was brittle. The brittleness in this case is due to the graphitic carbon particles, which are represented as the black lines. The background is hardened steel. The magnification is 400 diameters. This shows how the carbonizing exhibited in Fig. 29 affected the strength of the material.

Fig. 31 is a micrograph of a semi-steel test bar. You will notice that the graphitic carbon has more or less taken the form of globules. The rest of the material is steel in nearly a completely austenitic condition; austenite being a hard substance, the material is consequently very hard. There is also some martensite represented by the medium colored portion; this is also a hard material. Slow cooling of this material will make it considerably softer and tougher.

As this cannot be considered a one-man proposition, I would suggest that a committee be appointed to properly classify the different grades of semi-steel castings.

From the Chemist's Point of View

I also believe it only fair that we hear from a chemist and metallurgist who has handled thousands of semi-steel samples. This letter, addressed to the writer by C. J. Atkinson, Milwaukee, and dated July 19, 1916, is as follows:

"The series of micrographs and chemical analyses I have made for you of semi-steel and ordinary gray cast iron are exceedingly interesting in several ways. The difference in this semi-steel from gray cast iron is particularly noticeable in the formation of the graphitic carbon. In cast iron where there is a large mass of metal, the graphitic carbon is always found in large flakes, whereas with the semi-steel the graphitic carbon is in exceedingly small flakes and in small granules.

"This is very important as it is the graphitic carbon content in cast iron that makes it so brittle, by breaking up the structure of the metal. This is the reason why the samples submitted are so strong. Another feature is the high sulphur content of these steels. If this had been cast iron with this high sulphur, they would have been exceedingly hard because sulphur has a tendency to promote chill.

"Another factor which helped the material, in none of the samples have I found any blow holes or microscopic cavities. The material appears to be exceedingly close.

"In nearly all the samples examined, the combined carbon content was high. This, of course, is due largely to the high

sulphur; in all cases with the exception of two which showed chill, the material is easy to machine. The combined carbon is the carbon combined with iron forming steel, and if the combined carbon content were 0.835 per cent, the whole of the iron would be in the form of steel.

"The samples examined averaged over 0.6 per cent combined carbon; therefore the average percentage of steel in the material was over 70 per cent. The various metallographic elements in the construction of all these irons are as follows:

"Pearlite which appears under the microscope or in the photograph as a dark substance, laminated or speckled under high magnification is really iron saturated with carbon, forming steel. Graphitic carbon appears under the microscope as black specks or lines. In most of the photographs, though, these cannot be easily detected as they are more or less obscured by the pearlite.

"The white or light colored areas which contain some slight specks or markings, are ferrite which can be described as iron containing a certain amount of impurities. In one or two of the samples there is another white substance which is absolutely structureless. This is cementite, which is a very hard, brittle substance. It is composed of iron containing a large amount of combined carbon. It is only found in those castings that have been chilled.

"Another feature that is extraordinary is the uniformity of this series. Although the castings were of exceedingly varying weights, some having very thick sections and others being exceedingly thin, the metal microscopically was exceedingly uniform, much more so than you would expect to find in gray iron as we know that where the section of a casting is light, there is a tendency for the iron to be exceedingly hard and brittle unless the chemical composition is modified to suit the weight of the casting."

Figs. 1 to 22 Inclusive, Also Figs. 27, 28 and 31 are Magnified 200 Diameters; Fig. 29 is Magnified 25 Diameters; Fig. 30 is Magnified 400 Diameters

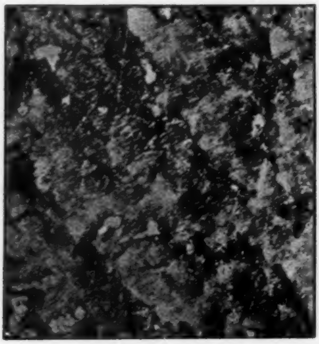


FIG. 1—SAMPLE OF SEMI-STEEL CONTAINING 50 PER CENT STEEL

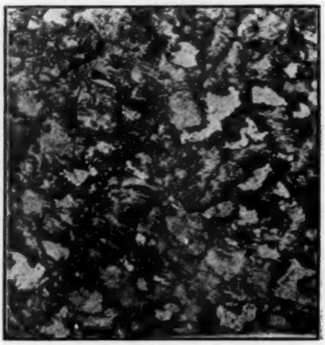


FIG. 2—PISTON CONTAINING 25 PER CENT STEEL

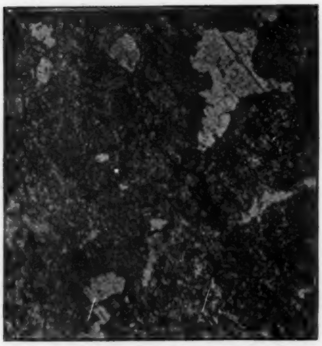


FIG. 3—SAMPLE CONTAINING 30 PER CENT STEEL

FIG. 4—PUNCH CONTAINING 40 PER CENT STEEL

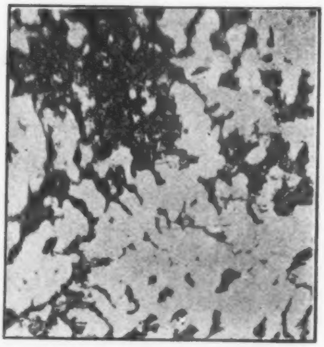


FIG. 5—THIN EDGE OF PULLEY CONTAINING 40 PER CENT STEEL

FIG. 6—SAMPLE CONTAINING 30 PER CENT STEEL

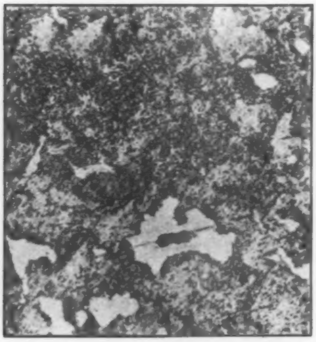


FIG. 7—ANOTHER SAMPLE CONTAINING 30 PER CENT STEEL

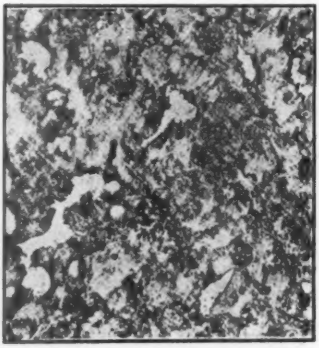


FIG. 8 — PACKING RING CONTAINING 30 PER CENT STEEL

FIG. 9—GRAY IRON CYLINDER

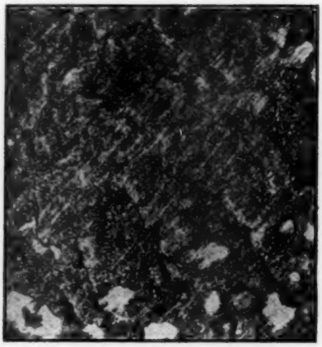


FIG. 10—SEMI-STEEL CONTAINING 0.75 PER CENT COMBINED CARBON

FIG. 11—PACKING RING CONTAINING 30 PER CENT STEEL, 20 PER CENT MACHINERY SCRAP AND 50 PER CENT PIG IRON

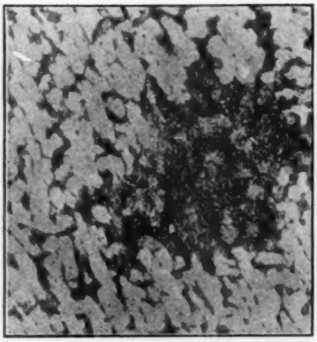


FIG. 12—CHILLED MOLD BOARD; 73 PER CENT OF METAL COMPLETELY CHILLED

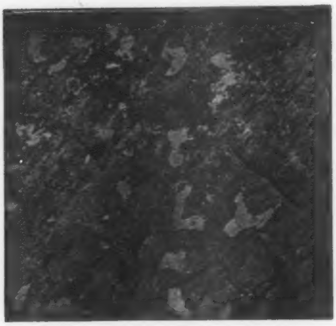


FIG. 13 — SPECIMEN OF SEMI-STEEL CONTAINING 15 PER CENT STEEL

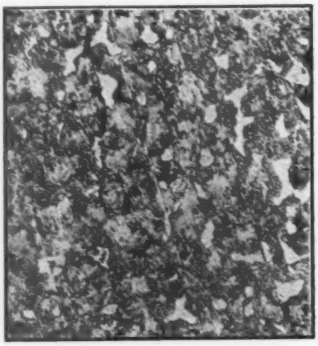


FIG. 14 — AIR MIXER CASTING CONTAINING 30 PER CENT STEEL

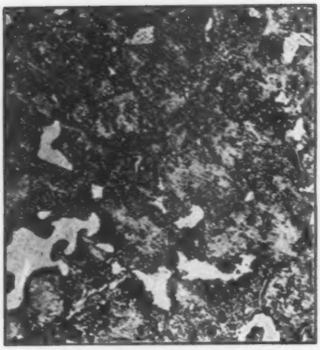


FIG. 15—BUSHING CONTAINING 50 PER CENT STEEL

FIG. 16 — BORE OF CYLINDER CONTAINING 25 PER CENT STEEL

FIG. 17—A SPECIMEN OF SOFT SEMI-STEEL—HARDNESS NUMBER 149

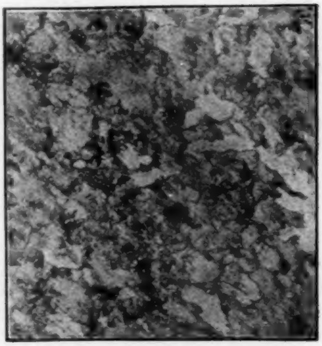


FIG. 18—CASTING CONTAINING 30 PER CENT STEEL

FIG. 19—STRUCTURE OF SEMI-STEEL GEAR BLANK, 33.3 PER CENT STEEL

FIG. 20—STRUCTURE OF SEMI-STEEL TEST BAR, TRANSVERSE STRENGTH 3,460 POUNDS

FIG. 21 — SPECIMEN OF GRAY IRON SHOWING GRAPHITIC CARBON

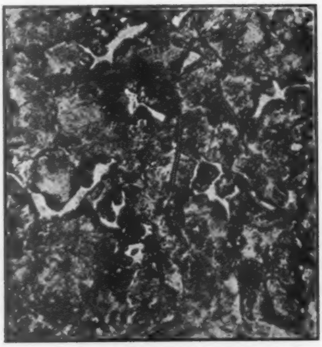


FIG. 22—STRUCTURE OF LARGE PISTON CONTAINING 35 PER CENT STEEL

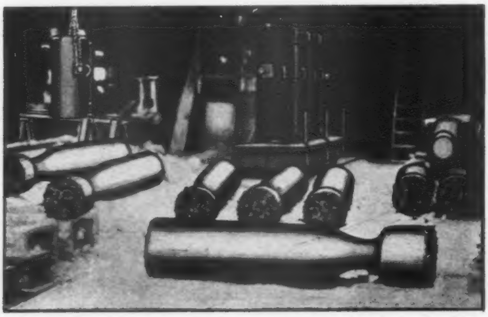


FIG. 23—SEMI-STEEL SHELL CASTINGS WITH SHRINK HEADS ATTACHED

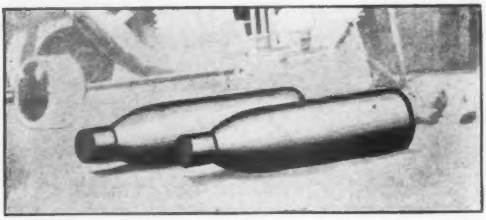


FIG. 24—FINISHED SEMI-STEEL SHELL CASTINGS

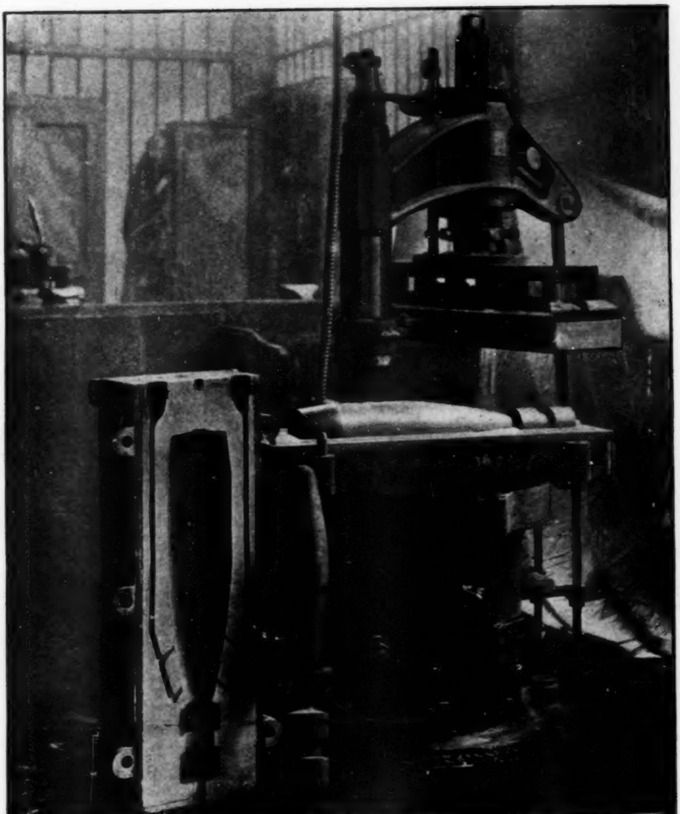


FIG. 25—ENGLISH PROJECTILE MOLDING MACHINE

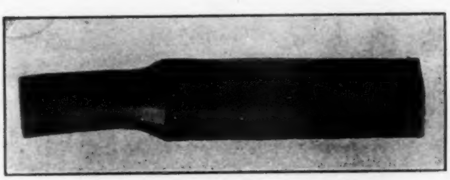


FIG. 26—SEMI-STEEL PUNCH

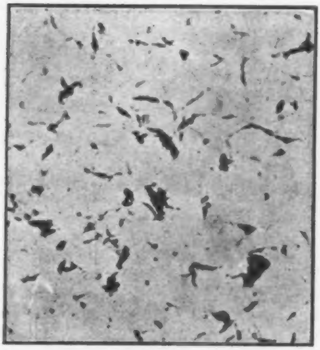


FIG. 27—STRUCTURE OF SEMI-STEEL PUNCH, UNETCHED

FIG. 28—STRUCTURE OF SEMI-STEEL PUNCH, ETCHED

FIG. 29—STRUCTURE OF PUNCH NEAR SURFACE OF METAL

FIG. 30—STRUCTURE OF BRITTLE PUNCH

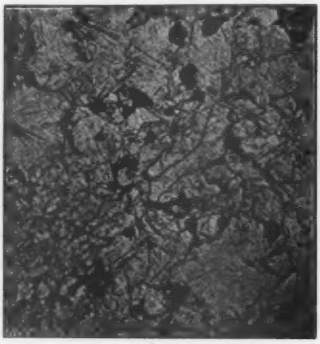


FIG. 31 — MICROGRAPH OF A SEMI-STEEL TEST BAR

Discussion—Semi-Steel

THE CHAIRMAN, B. D. FULLER.—This is certainly an interesting subject for discussion. If there are any questions you would like to ask Mr. McLain, now is the time to do so.

MR. R. S. MCPHERRAN.—I just want to correct an impression. On page 585, paragraph 4, Mr. McLain refers to the fact that up to 1902 and 1903 he can find no record of men using a large amount of steel in cupola practice. Mr. McDowell, in Chicago, working with Mr. Harrison, used 25 and 30 per cent steel in 1893, about 10 years before the date referred to by Mr. McLain.

MR. DAVID MCLAIN.—What does that mean?

MR. R. S. MCPHERRAN.—You spoke as though semi-steel was a new thing in 1902.

MR. DAVID MCLAIN.—You are wrong. Mr. McDowell had been making semi-steel many years before I thought of using steel in small castings. My contention is that I am the first foundryman who successfully used large percentages of steel scrap in cupola mixtures for castings of light section, and I want that to go on record. Mr. McPherran, I never claimed to be the originator of semi-steel as several patents were issued in England more than 50 years ago covering semi-steel, and steel also was thrown in ladles when I was a boy.

MR. C. C. KAWIN.—Are you a believer in analysis entirely?

MR. DAVID MCLAIN.—Yes.

MR. C. C. KAWIN.—I am a believer in all iron being alike if the analysis is alike, with very few exceptions. I have never been a believer in anything else since I have been in the laboratory in 1889. I have always believed I could use anything in the cast as long as I kept the analyses at the proper point and took care of my gates and risers.

MR. DAVID MCLAIN.—I agree with you.

MR. KAWIN.—I did not recognize steel or anything else. They are all in the same family. It is all a question of the

amount of impurities and regulating them accordingly. We used steel in the car wheel business in 1890 and 1892.

MR. W. F. GRAHAM.—I would like to ask Mr. McLain a question. I would like to know whether the addition of steel to the gray iron mixture carries any inherent qualities to the steel other than would be carried there by ordinary gray iron and scrap mixtures which have the total carbon diluted sufficiently down so that the silicon has the ordinary effect of increasing silicon and throwing out the carbon into another form. In other words, do you think that the additional steel carries some of the inherent physical qualities of the steel into a gray iron mixture?

MR. DAVID MCLAIN.—It is not so much a question of what the steel itself carries as the fact that the steel has a strong affinity for the elements and absorbs large percentages of carbon from the coke. The steel itself always helps the metal because the steel is the purest element that is charged into the cupola. I have been asked the question as to why does steel help iron, and that is the answer.

MR. C. C. KAWIN.—Of course, steel does not always help iron. Steel has a limited amount of impurities, and you would not want to reduce the impurities in certain kinds of iron; you would want to increase them. In fact I take the position that even in light work I prefer to have a little higher sulphur because it makes a little cleaner and stronger castings. In light work, where they run 0.04 per cent, I think that the 0.06 per cent is better than 0.04 per cent.

MR. DAVID MCLAIN.—We like the low sulphur material all of us do, I think.

MR. C. C. KAWIN.—It is only a question of economy. You can use more scrap with low sulphur pig iron than you can with the other.

MR. KELLY.—The capacity for absorption of the deleterious element is greater in the extremely low sulphur proportionately than in the higher sulphur.

MR. DAVID MCLAIN.—In numerous samples of semi-steel the average foundryman would be greatly alarmed over the high sulphur that he finds there, but we are using plenty of

high manganese and we have a manganese sulphide there that gives a grand metal.

THE CHAIRMAN.—Regarding the absorption of carbon from coke, I see that in another paragraph of Mr. McLain's paper, page 591, he says: "Steel scrap should never be added to a ladle of molten metal, as numerous tests have proved that many imperfections in castings are traceable to this practice." I think we have all had our experience in that line. I would like to ask if you have made tests of some of the mixtures produced at different temperatures from your cupola and the results.

MR. DAVID MCLAIN.—To produce good semi-steel you have to have the highest temperature obtainable. When we had low temperature it meant poor melting, and we had semi-steel that was a misnomer because it was not the semi-steel that we aimed to make.

MR. C. C. KAWIN.—I do not think you have the right idea on that steel in the ladle question. I do not think it is a question of the absorption of the carbon in that particular, so much as it is the question of the amount of heat you have in your ladle to melt your steel. I was interested in Mr. Evans' talk. As to the sulphur question, I had occasion one time to test a car wheel with 0.9 per cent sulphur and it stood both the thermal and drop tests. We made the determination 15 or 20 times to be sure we were right.

MR. KELLY.—I infer from Mr. Kawin, from his experience with sulphur in car wheels, that the 0.15 per cent in car wheels that Mr. Evans referred to is extremely low.

MR. C. C. KAWIN.—Very low; 0.18 per cent is closer to it and 0.20 per cent is very likely the average. Our sulphurs in our laboratories do not agree with many of the others. Our sulphurs are probably 20 or 25 points higher than those of many laboratories. The reason is that we take care of the residue in the sulphur determination and many laboratories do not. It is impossible to make a car wheel with 60 or 70 per cent old wheels and about 15 per cent pig iron and get 0.12 per cent sulphur. We get 0.180 and 0.190 per cent. The old car wheels have high sulphur.

Mr. Kelly.—Nine foundrymen out of 10, in the commercial laboratories, simply get the evolved sulphur.

Mr. David McLain.—I do not know whether you have all read the preprint or not, but the great and important point of semi-steel, as I see it, to the average layman is that steel will absorb carbon from the coke and we cannot have hard spots. The general cry is hard spots in semi-steel. There cannot be any excuse for hard spots in semi-steel. It is not steel before it is fused. It is a highly carbonized metal. We found in our experiments that if we used any ladle additions we were in trouble, so we did all of our melting, for many years, in the cupola. There is no need of ladle additions.

Mr. R. F. Harrington.—I would like to ask Mr. McLain if he would recommend by-product coke with high carbon for semi-steel mixtures? Can better semi-steel be made with high carbon coke, such as by-product coke, than with the Connellsville coke?

Mr. David McLain.—If the Connellsville coke is a high carbon fuel, that is what you are aiming for; you want the carbon.

Mr. R. F. Harrington.—The average of Connellsville coke will run 88 and 89 as compared with 91 and 92 for the by-product coke.

Mr. David McLain.—I would not like to make the statement as to just what we found in the different cokes, that is, so as to mention them by name. I do not think that would be fair.

The Chairman.—Bearing on that question; last week we had a little experience along that line. We had some coke which was rather below the average in carbon and high in ash. We melted semi-steel that day and tests showed that it was off. We did not change the mixture, but the very next day put the same mixture in the cupola, but with a very good coke, high carbon and low ash, and we got a remarkable increase in the strength. That goes to show, in my opinion, that the quality of the coke has a decided bearing on the quality of the material.

Mr. David McLain.—I will pay 75 cents to $1.00 a ton more for good coke than for poor coke, if I am in a jobbing shop where I have got to have all of my castings machined.

The Chairman.—I might say there was $1.25 a ton difference in these two cokes.

Mr. David McLain.—I think I would stand that.

Mr. R. F. Harrington.—I think Mr. Fuller has brought out the question very well as to the high carbon coke and the low carbon coke. I would like to ask if you have noticed any difference in the micro-structure of semi-steel melted down with Connellsville as compared with that melted down with by-product coke, in the graphite distribution?

Mr. David McLain.—No, I have not. If you will send me your address I will be glad to give you some information later on.

Mr. R. F. Harrington.—As I understand it, a by-product coke gives a much more uniform distribution of the graphite and much finer flakes, which, according to theory, would very materially better an iron, and I was just wondering whether any person here has had any experience with the two cokes.

Mr. David McLain.—Probably Mr. Kawin could answer that question.

Mr. C. C. Kawin.—What is the variation between the high carbon and low carbon coke that you refer to?

Mr. R. F. Harrington.—Three per cent.

Mr. C. C. Kawin.—Melting at the ratio of 9 to 1, your variation would be very small.

Mr. R. F. Harrington.—Theoretically it would, but practically it has been called to my attention that there is quite a little difference; assuming that there is 3 per cent difference, more than the proportion of the difference is absorbed by the iron, that practically there is a great deal more carbon absorbed by by-product coke than figures out on paper, and I wondered whether anybody had noticed that.

Mr. C. C. Kawin.—You have got to assume a condition there of the same temperature of the metal or a different absorption would take place.

Mr. G. E. Jones.—I might say, from my observation of the tests I have actually made, I find that the fixed carbon of the

coke, whether it varies 1, 2 or 3, or even 4 per cent, has really little effect on the strength and the grade of the material that is made or the carbon absorption. It is due, as I find it, almost entirely to the control of the temperature. If your metal is cold, in other words, if you do not use sufficient coke to get a very high temperature, your metal will not absorb the carbon that it does with a high temperature. I find that the total carbon will run higher, even though I use a very large proportion of steel if the metal is very hot, and it has been proven by test after test that I have taken samples of and had analyzed. I might add that Mr. Kawin has been the gentleman who furnished the analyses. He did not know it when he did it, but he did it with the sample.

Mr. C. C. Kawin.—I do not believe much in the accuracy of the total carbon determination.

Mr. G. E. Jones.—I want to differ with Mr. Kawin on the question of total carbon. I have had several discussions with him on that subject. I have had some very sad experience with the question of carbon. For instance, on one occasion I tried to make some iron using a very high percentage of steel and a low coke ratio with a low manganese, and I had a lovely time. The total carbon was very low. Mr. Kawin made the analysis. I tried practically the same mixture using a larger percentage of coke in increasing the temperature of the metal and running the manganese up and the result was so different that you would not recognize the two metals as being almost the same, as far as the original elements going into it were concerned. I think if any of you wish to make the tests that you will find that a cold metal, or not using sufficient coke, will show a low carbon absorption and it will also show the same thing with a variation of manganese content; but you will find, I think, that the temperature has the largest bearing on the ultimate result.

Mr. Kelly.—The question of high carbon in foundry coke is a very interesting one, but the point of carbon does not determine the value of real good coke alone, as I think the men who have used a good deal of coke will tell you that the constituent of the ash after you reach a certain point is its

goodness. All of us have seen a coke at 89 to 91 that was superior to coke with 95 carbon on account of the content of the ash.

THE CHAIRMAN.—I do not want to get away from Mr. McLain's subject, but this is something I cannot resist injecting right here. The question was asked me by a gentleman today if I thought he could make good iron with a coke analyzing 15, 16, or 17 per cent ash. If any one of you think you can make good iron with that, you can tell him.

MR. C. C. KAWIN.—There is no question but that you could make good iron with that, but you should use more coke. We were compelled to use at Denver high ash coke containing 20 per cent. That was the only material we had at that time.

MR. DAVID MCLAIN.—There are many foundries making semi-steel today that do not pay very much attention to the manganese content and they never will make satisfactory semi-steel. That is the question I have in mind. When we began experiments the best authorities at that time claimed there was not temperature enough in the cupola to melt the manganese, but as we melted hundreds of tons of it in crucibles in a very short time, I knew we would surely be able to melt it in the cupola. The fallacy of some of the old text book theories is certainly exploded when we have got 2 per cent manganese in a casting. The old theory was that above 0.85 per cent it hardened the metal and that you could not pull it, even in heavy sections.

MR. G. E. JONES.—I had one very interesting experience that I think would probably be interesting to you. I was starting a converter steel shop and the party who owned this equipment desired to get very cheap metal and he requested that I use as high a percentage of steel as it was possible to employ. We started by using 60 per cent steel in the mixture, with the manganese running 1.40 per cent and the resultant metal was very gratifying and we got very fine results. Then he made another request that we increase the amount of the steel, if possible, and we increased it to 70 per cent with the manganese running about 1.40 per cent and the silicon in the mixture about 1.70 or 1.75 per cent. That also gave us very

good results. Then he made the request that we still further increase the amount of steel and I was a little bit afraid of it. I told him that if he would assume all responsibility I would attempt it, and he did, and the next day we melted 80 per cent steel, using 9.5 per cent silicon pig and the manganese ran about 1.40 per cent in the cupola. The resulting metal had a fracture that was a beautiful, soft, velvety gray. It looked so good that the superintendent of this plant decided that he was going to use it in some very large fittings, a large 36-inch "L" that was specified to be made of semi-steel, and he asked me if I would call that semi-steel and I told him I certainly would; if such a thing or anything could be called semi-steel that sure was it, so he poured it. The machine shop foreman thought he was going to have a great deal of trouble, but it machined beautifully. Of course, there was a drag to it that they noticed. When they analyzed the metal it carried 3.75 per cent total carbon, using 80 per cent steel to start with. We had some very fine results.

MR. DAVID MCLAIN.—Most all of the old data on cupola practice were not applicable when we began melting steel in the cupola and several changes had to be made. Mr. N. A. Christensen, of Milwaukee, deserves a great deal of credit as he insisted that metal 5/16-inch thick would stand 200 pounds air pressure although other engineers of that time allowed 1 inch thickness. The metal not only stood 200 pounds air pressure, but when sledging the castings—testing them to destruction—the metal would dinge down, just like steel castings, before cracking.

MR. G. E. JONES.—A gentleman has just asked me a question that would lead me to believe that I ought to amplify some remarks I made. He asked me if we melted that 80 per cent steel mixture very hot. I wish to say that if anybody wishes to melt a mixture containing a very high percentage of steel they want to be very careful to use sufficient coke and know that the wind is right. That metal must come from the furnace almost silver white, in fact you can hardly look at it. We used 0.48 per cent phosphorus. We had to have it that way in order to make successful converter steel with it. I just want to caution the members, if any wish to use a high per-

centage of steel, it is possible and it gives very fine metal, but get it very hot, so that you won't bung up your cupola.

THE CHAIRMAN.—I do not wish to drag this question out, but that brings up this point. Mr. McLain makes this statement on page 591: "No more coke is required to melt semi-steel than gray iron. In fact, scientific melting has taught melters to bring down hot iron with less fuel than formerly although they are now using 20 to 50 per cent steel."

MR. DAVID MCLAIN.—I do not think the average foundryman today knows what the foundrymen used to do, the ones I referred to. We find many men that I thought were pretty well up, and they believe that they are, who do not seem to be getting the results that they should, but I do not decry what any man is doing if he finds that that is the best for his practice; maybe if I was in his shop I might have to do the same thing that he is doing. But our records show that 100 pounds of 90 per cent carbon coke will melt 1,000 pounds of semi-steel nicely, from 30 to 50 per cent steel; bearing this in mind, that in a small charge we cannot put large pieces of steel. Of course, if we put in large pieces of steel, we should have more coke.

THE CHAIRMAN.—I agree with you when you qualify that and say 90 per cent carbon coke.

MR. DAVID MCLAIN.—That is the kind of coke we are aiming for and if a majority of the foundrymen in the United States will specify 90 per cent carbon coke it is not going to be long before they will make it for you. They are making it today, so get it. It is worth the price.

MR. G. E. JONES.—I would like to say that usually the foundrymen make the mistake of trying to save a penny on coke and losing $100 on the castings. The average foundryman will read his trade papers, and it has always seemed foolish to me that a man will advise foundrymen to use a small proportion of coke, getting a ratio of 10 to 1. It seems to be a mania to get a coke ratio of 10 to 1. To my mind, you must get your iron hot. If you must use more coke, which is the cheapest material around a foundry, the cost of it is insignificant, and I find the best results can be obtained without trying to save on the coke.

One-Third of a Century in a Gray Iron Foundry

By Alfred E. Howell, Nashville, Tenn.

Since the fall of 1881 the art, trade and mystery of the founding of gray iron, has altered very materially. The art has been largely transferred from the molding room to the pattern shop, the trade has increased enormously and the mystery has almost, if not quite disappeared.

I do not represent that I shall offer results of original research on my own part. If a minister were expected to be original in thought and substance each Sunday and Wednesday night, those discourses would be decimated. But the interest of the old and ever new story loses nothing by repetition. If in noting and commenting upon advances in foundry practice, I shall fail to enlighten some, I shall hope to interest those, newer in the game, by touching upon the essentials and dispelling some illusions which make progress difficult for the inexperienced.

The title of this paper gives one some latitude which I shall not abuse by undertaking to cover a large field. A third of a century in the life of either of us is an imposing period, but it is really a little past the 35-year mark since the writer began to be a foundryman. When the job will be completed is another question.

Scarcity of Literature

In 1881 there was little literature of the foundry. What there was, dealt empirically with melting and molding special work. The character of the work I was engaged in, namely the production of light castings for stoves of many descriptions, and hollow-ware, mantles and grates, I could not even find mentioned in English books that I purchased in an endeavor to get some advantage by reading. What was told

in British books was so complicated and different as to conditions and equipment that I despaired of learning anything except by the rule-of-thumb method, which in fact was the only method at that time.

I do not mean to say that works did not exist, but to an average foundryman they were not accessible or they were unknown. The first writer who impressed me with his clear and definite statement and logical reasoning was W. J. Keep, of Detroit. The publication of THE FOUNDRY was begun about 1892, and therein began to appear articles by the ablest and the best. Here I noticed first the articles by Mr. Keep, and working back I compiled all I could find and located a number published in other journals. His scientific methods, direct and terse treatment of the subject in hand, appealed to me so strongly that I made a visit to Detroit to see him and the adoption of his ½-inch square 12-inch test bar was to me the beginning of foundry wisdom, and ushered in the day that brought relief from the horrible anxiety of cracked castings and hollow-ware that rang like a bell, a gang-way filled with scrap and a shop full of disgruntled molders.

Mr. Keep, as I afterwards learned, had been making his investigations since 1885 and in the years following had made many contributions to various publications of which I knew nothing, and learned societies of which I was not a member.

Experience, the Great Teacher

It was not the fashion then to read, but to learn by rote from some one supposed to know, and who could usually assign no consistent reason for his course of action. This was covered by the incontrovertible argument *experience*. Experience seemed to teach that a heavy casting shrank more than a light one, a thick section more than a thin. With this belief well grounded, it was difficult to see any consistency in the behavior of certain castings. When we learned that such was not the real truth, but that thick sections shrank less than thin, and why, we began to get out of our difficulties.

While I gladly would utilize the time at my disposal in a tribute to Mr. Keep, I am trying just at this moment to

be useful to my fellows and consider that I am, when I suggest that you get his published volume on "Cast Iron". It is so concise and elucidating that it would be very difficult to state results in shorter space, so I merely refer you to it. The particular subject which he treats, of greatest importance to me, was *Shrinkage,* and of this Prof. Thomas Turner, of England, said, "The experiments and investigations of Mr. W. J. Keep, of Detroit, embody the whole of the trustworthy data available;" certainly a very high compliment. This was in 1895. There is nothing that has superseded nor surpassed his investigations so far as I know.

The reason I mention this is that I visit other foundries as often as possible and I rarely find that the management knows what their shrinkage is, nor has it occurred to them that it is a matter of any importance. Now it is true that many *get by* without it, just as many, very many people live without a physician, dentist or occulist. Probably they are due our congratulations, but more probably they need these offices and do not know it.

Shrinkage Tests

We have found that by the use of a shrinkage bar test at each cupola, we can keep our iron more uniform than otherwise, and a tendency towards high shrinkage and hardness is caught and corrected before the consequent loss is suffered. A shrinkage satisfactory for our shop is the standard for us, not the shrinkage of another shop. We find that we can not reach what was the old time-honored standard of ⅛-inch to the foot, which would be 0.125, but that our normal is 0.145.

It should be clearly understood that the shrinkage measures the resultant of the effect of all the elements—sulphur, manganese, phosphorus and silicon—and that the higher the carbons the less silicon will be required to attain the desired low shrinkage, and that the degree of shrinkage varies with the character of work required.

So it is a relative matter and not one to which you can apply a hard and fast rule. Even if we had a daily chemical analysis, which we have not, I would still prefer a test bar to

give us the resultant shrinkage. Castings that have to be assembled as in a range, do not fit unless the shrinkage is fairly uniform, and it happens that we are surprised at times that castings made at different periods do not go together so well as those made at the same time. If shrinkage is kept uniform this does not happen.

Silicon Holds Shrinkage

As to the exact amount of silicon required to hold a shrinkage of 0.145, we do not concern ourselves rigidly. We figure 2.90 per cent silicon in the mixture and deducting 0.25 per cent for loss in melting, this leaves 2.65 per cent, and if this lowers the shrinkage we will slightly lower the silicon next day. We assume that the men who conduct so large a business as that of making pig iron, would not connive at petty deception and we take their analyses as approximately correct, and by the results find that they are so.

I have no criticism to offer of those who employ their own chemists, but your own are as likely to make errors as those of the furnacemen, and I believe it best to assume honest dealing on the part of all until you know the contrary to be the case. If you find that you do not get the results, reasonably expected, it is time to have detailed analyses.

In the third of a century just passed, we have progressed from empirical knowledge to scientific knowledge. Horace said, "felix qui potuit cognoscere rerum causas," and we are indeed happy today in knowing the causes of things, more closely than our predecessors.

From the iron I would revert a moment to the cupola, with the understanding that I am not proposing to go into any technical detail. When I began in the foundry business there were very quaint and curious theories about the size and shape of tuyeres. This has about all given way to one essential. *Let your air in. Don't dam it up in the bustle with the notion that a high pressure there will shoot it to the center of the charges.* It is the volume of air in relation to the amount of fuel to be consumed that is the controlling factor, and this is

regulated at the blower. I might have said that in regard to the breaking of pig iron we have run both ways, for years. I consider that for a shop requiring fast melting and hot iron, it is better to break, and that the labor is about offset by the saving in coke.

The Question of Slagging

I also believe, that while we melted for many years without slagging, that in running over 10 tons it is preferable to slag, using a front trough only, with a basin to catch the slag, which is carried off to the side.

One of our cupolas is 84 inches in diameter, lined to 64 inches from which we get a stream too heavy to be caught in hand ladles. We have a transverse trough which is regulated so as to divide the stream, thus making it easy for two lines of molders to catch at the same time, each getting hot iron which he conveys to his floor on light trolleys swung from 8-inch I-beams. These beams also carry the heavy trolley trucks which remove the castings or transfer sand or other heavy material.

Since THE FOUNDRY was started in 1892 and certainly since the publications of our Association began in 1896, there has been a running fire of splendid articles dealing with every phase of foundry practice in detail, so that no one who desires to be informed should now be ignorant of methods in general use.

Match-Plates and Aluminum Patterns

One revolution which has taken place is the almost entire substitution of aluminum for iron patterns and the hinged match-plate instead of the loose pattern. I refer, of course, to light castings. The match-plate, of course, is not new. We have iron match-plates at least 35 years old, that were discarded as impractical, and other iron match-plates that we had used many years for small pieces on the bench.

The progress of the manufacture of aluminum until the cost was reduced to 25 cents and less per pound, developed new uses for it, and the foundry appropriated this material

rapidly for patterns, as it got cheap enough to be available—but not as loose patterns. The match-plate was concomitant with the aluminum pattern. The extra thickness in the plate gave the necessary rigidity and strength, and assured straight edges.

There have been a number of patented processes, mainly consisting of types of match-plate and flask hinges and pins, and methods of making them, which have been minutely described in various publications. We developed our own method and evolved our own hinges. With a match-plate the skilled work is mainly performed in the pattern shop. This does not mean that merely legs and arms can make a good casting. The molder must still see to it that his sand is in proper condition; he must know just how to ram and how to pour and above all, he must know exactly how to place his bottom board and clamp it, to prevent the sagging of the drag.

Skill in Match-Plate Work

One might say that in molding from a well designed match-plate, the skill required is almost eliminated, but for the fact that two things may happen and do happen. Either the drag settles or drops away from the plate, making excessive weight in the casting, or the mold is *clamped-off* by getting too much sand under the bottom board. This requires judgment and care, especially with castings of large, unbroken surface. Small castings for the bench or squeezer or machines of various types, do not present this difficulty.

The advantages of the aluminum match-plate are several. Breakage is almost eliminated, and with iron patterns, in our case, this was a serious drain. The wooden follow-board is done away with, only a skeleton support for the larger plates being necessary. The filing and dressing of the aluminum plates is much more rapid and the total cost is about the same as the total cost of the iron patterns. There is the necessity of having flasks fit the plate, but this is overcome by making all flasks and plates to certain standards.

We do not believe in making everything match-plate, for the sake of saying so. If a certain casting can be just as

safely made loose pattern, and the molder prefers it, we continue the loose pattern method. Some castings that we do not make in sufficient quantity to justify the expenditure for new patterns, we continue as they have always been, and I suppose the next third of a century will find us doing certain work just as it was done in 1881.

Use of Non-Shrinking Metal

It may naturally be asked, "how patterns that are matched, are fitted," as exact fitting cannot be done in the wood. We take off non-shrinking metal castings from the wood. These are dressed and fitted and the plates made from them. The non-shrinking metal is a mixture of lead with enough tin to stiffen it and secure necessary straight lines and enough antimony to counteract the shrinkage. We use a ½-inch square, by 12-inch bar to test when this is the case. We also cast a bar from each lot of aluminum to ascertain its shrinkage and make allowances accordingly. This we find usually varies from 0.170 to 0.180 for No. 12 metal.

If in writing this short paper I can stimulate the reading of the Transactions of our Association, and the results of the investigations made by our honored members, some of whom have devoted the best efforts of their lives for our welfare, I shall be content.

I have hoped to bring out some discussion of questions I have merely touched upon, but which have been dealt with ably by others and will continue to be studied by the brightest minds ages after you and I, like streaks of morning cloud, shall have melted into the infinite azure of the past.

The Thermal Reactions of Cast Iron

By Prof. Thomas Turner, Birmingham, England

When the invitation of the secretary of the American Foundrymen's Association, to contribute a short paper on the thermal reactions of cast iron, was accepted, it was explained that recent conditions in England have not been favorable for the prosecution of original research; and that all that could be attempted would be to write something which might, perhaps, make more clear to the practical man, some of the important scientific facts which underlie the successful application of his art.

Adopting the time honored language of Lord Macaulay, it may be assumed that "every school boy knows" that substances when heated expand, and that with every increment of temperature there is a corresponding increase of volume. Conversely when any material is cooled there is a corresponding diminution of volume, the amount of such contraction per unit of temperature depending upon the inherent properties of the material. But though it is true that over a short range of temperature the change of volume is strictly proportional to the change of temperature, it is not strictly true over wide ranges of temperature. Solids, for example, have a higher rate of expansion when near their melting points than at lower temperatures. Further, in very many instances, accurate observations show that there are distinct irregularities, and that these are indications of important physical, allotropic, or chemical changes which occur at certain definite temperatures.

Irregularities of Water and Cast Iron

It is noteworthy that two of the most important substances with which we have to do, namely, water and cast iron, show remarkable interruptions in their rate of contraction when

cooling—in fact actual and marked expansion takes place. The profound and beneficial influences which result in the climatic conditions of our globe, from the expansion of water when changing to ice, are well known to all geographers. The inconveniences which accompany such advantages, are known to the householder and the engineer. The expansion of cast iron during, and shortly after, solidification has the great advantage of rendering the metal specially suitable for giving a perfect reproduction of the desired pattern. But this advantage is accompanied by troubles which beset the foundryman, and which often lead to the production of castings that are warped or bent, or which spontaneously crack after being allowed to cool.

In comparing water with cast iron, a marked difference in constitution is observed. To the chemist water is a compound, composed of oxygen and hydrogen, yet physically it is all one thing; one "component" or one "individual". So long as it is liquid it is one "phase". When water passes into ice we have another phase, while water vapor is a third phase. With the gaseous phase we are not interested at present, and it introduces the further variant of pressure. Considering only the liquid and solid phases, if these be mixed together in any proportion and kept at exactly 0 degrees Cent., no change will occur in the weight of ice or of water. But if the temperature be raised, and sufficient time given, the whole of the ice will melt; if the temperature be lowered, and sufficient time given, the whole of the water will freeze. Hence there is only one temperature at which the two phases can remain in equilibrium. With a falling temperature, no matter how many phases may be present, only one phase can separate at one time.

A Heterogeneous Mixture

Cast iron is not an element, or a compound, or a solution, but a heterogeneous mixture, including a number of "individuals" or "components". The elements which are always present are carbon, silicon, sulphur, phosphorus and manganese. Variable small quantities of other elements are also to be detected. The actual substances (or "individuals" as Prof.

T. W. Richards styles them), in cast iron include iron (or ferrite), carbon, iron carbide (Fe_3C), iron silicide (Fe_2Si), iron sulphide (FeS), iron phosphide (Fe_3P), and manganese sulphide (MnS). There are mixtures of the foregoing, yielding eutectics, such as the iron carbide eutectic with 4.3 per cent of carbon, the iron-carbon-phosphorus eutectic with 2 per cent carbon and 6.7 phosphorus. There is also pearlite with 0.9 per cent carbon. There are also solid solutions, such as silico-ferrite which has the same crystalline habit, or is isomorphous with iron. It therefore is not enough merely to know the ultimate chemical composition of our cast iron. We must know in what form the elements are present, and how they are arranged.

Having so complex a structure and composition, in the solid cast iron, the question naturally arises—Do these substances exist in the separate state from the beginning, or is there a definite order and sequence of formation? A generation ago no satisfactory answer could have been given to such an inquiry. The use of the microscope and the pyrometer, and the application of the "phase rule", have done much to make clear what really occurs. In the language of Dr. Stead, all cast iron is "born white". In other words, when it commences to solidify the carbon, silicon, phosphorus, and other elements are in a state of solution. Any separation which occurs takes place afterwards, as the metal cools. It takes place in definite order and at definite temperatures. So long as the temperature is falling, and sufficient time is given for equilibrium to be attained, only one phase can separate out at a time. If there is a fixed temperature at any point during the process of cooling, then two substances may separate out together and yield an eutectic. In no case can more than two phases separate out together.

What has been just stated is true only so long as sufficient time is given for equilibrium to be attained. In a large casting, which is cooled very slowly, we approximate to equilibrium conditions. But in many cases the cooling is so rapid that one separation is not completed before the temperature is reached at which another begins. We have thus an overlapping or lag, and with extremely rapid cooling changes may be alto-

gether suppressed. In such cases heat which would otherwise have been evolved is retained in the solid, and the result is called "metastable". Metastable solids are often hard and brittle, like glass, or white cast iron. By annealing at a proper temperature, the heat which has been retained internally is allowed to change its form, and to be liberated; the condition of equilibrium is attained, and the solid becomes relatively soft.

Expansion of Cast Iron

Returning now to the subject of expansion in cast iron, it may be noted that practical men were convinced that expan-

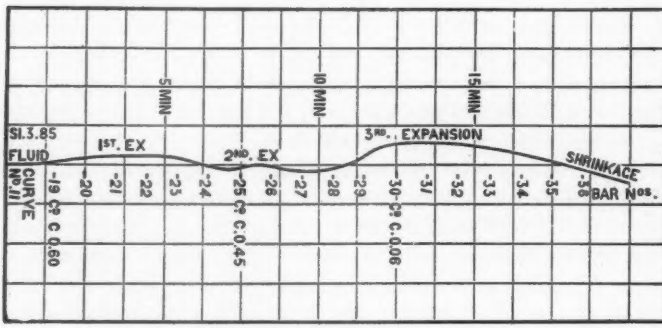


FIG. 1—CURVE SHOWING RESULTS OF KEEP'S TESTS

sions occurred long before there were any scientific observations to support that view. Elsewhere I have given a brief summary of the earlier experiments of Malet, Roberts-Austen and Wrightson.* But these preliminary observations did not carry us beyond the point at which the metal became solid in the mold. Nor was attention given to the influence exerted by the various elements which are present, in widely different proportions, in different samples of gray cast iron.

Really accurate and useful knowledge on this branch of the subject may be said to commence with the work of W. J. Keep, of Detroit, who introduced an apparatus for automatically recording the changes of length in a sand cast bar from the

*Journal of The Iron and Steel Institute, 1906, Vol. I, p. 48.

moment it begins to solidify until it is cold in the mold. By modifications of this method, and with the addition of temperature measurements, the question has been since more fully investigated, in my laboratory with the aid of Picken, Simpson, Murray, Haughton, Ewen, Hague, Chamberlain and others. The observations have not been confined to cast iron, but have been extended to brass, bronze and other alloys.

A fundamental experiment by Mr. Keep calls for special mention. A number of similar bars were poured from the same ladle, side by side, at the same time. From one of these an autographic record of changes of length was obtained. The others were quenched, one at a time, at regular intervals during cooling. The quenched bars were afterwards analyzed. The results are represented in Fig. 1. The metal was a gray phosphoric cast iron, containing 3.85 per cent silicon. It showed three distinct expansions, which reached their respective maxima at about four minutes, eight minutes and 14 minutes after casting. It was not until about 20 minutes after pouring that regular contraction commenced. The combined carbon had fallen, during these expansions from 0.60 to 0.06 per cent in the chilled bars.

Keep's Work Important

Mr. Keep's work was of importance not only because it showed the nature and sequence of the expansions which take place, but also on account of its suggestiveness for further inquiry.

The questions which naturally arose were those of dealing with the cause or causes of the expansions, the thermal changes which occurred, and the changes in structure and properties which resulted therefrom. In the investigations which ensued I was fortunate in having the assistance of Dr. O. F. Hudson. Among the facts ascertained were the following:

1.—That most metals and a number of alloys give a regular contraction in the cast bar.

2.—That with white cast iron, free from phosphorus, there is only one small expansion, and one temperature arrest, which occurs at about 670 degrees Cent.

3.—That with gray cast iron, free from phosphorus, there are two well marked expansions, and two distinct temperature arrests, which occur at about 1135 and 695 degrees Cent. respectively.

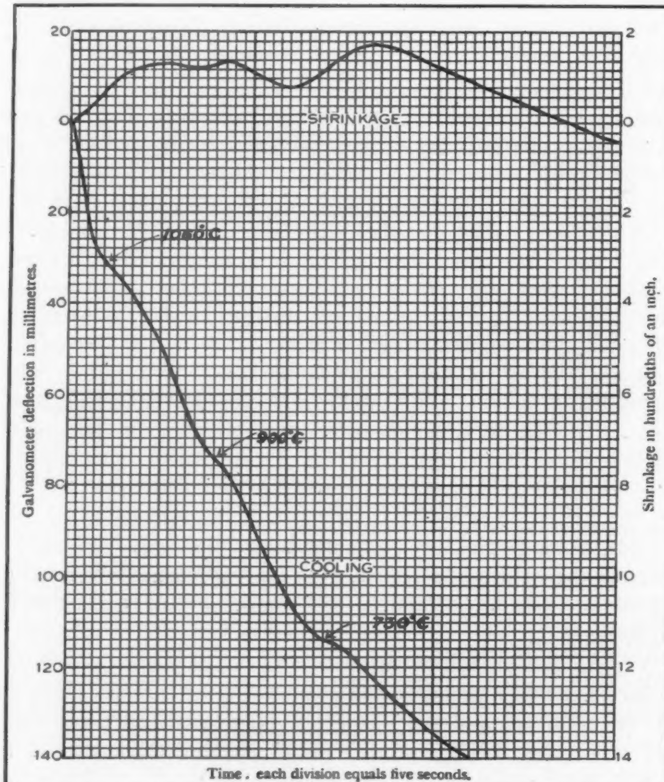


FIG. 2—EXPANSION AND TEMPERATURE CURVES FOR GRAY PHOSPHORIC IRON

4.—That with increase of silicon these arrest points occur at higher temperatures, and nearer together. In other words, though both are raised, the lower, or pearlite point, is raised more than the upper, or iron carbide eutectic point.

5.—That the addition of a small quantity of manganese, together with silicon, diminishes the rise in the pearlite point, and leads to a more complete decomposition of the pearlite carbide, in other words to the production of fine grained graphite from the combined carbon.

6.—That in gray irons containing phosphorus there is an additional, or third arrest, which occurs at a temperature between those given, or at about 900 degrees Cent. A typical expansion curve, and the corresponding temperature curve for gray phosphoric iron is given in Fig. 2.

There are doubtless other volume changes besides those that have been mentioned. These include what occurs when silicon dissolves in iron to yield the solid solution known as silico-ferrite.* The separation of manganese sulphide, and iron sulphide, during the cooling of cast iron, doubtless also produces volume changes though such changes are relatively unimportant.

Conclusions Confirmed

The most important of the conclusions which were derived from the experiments conducted at the University of Birmingham, have since been confirmed by other investigations, employing various forms of apparatus. Special mention should be made of the careful work of Prof. Wüst, of Aachen, and the practical applications by Messerschmitt. More recently also Mr. Heggie, of Birmingham, who is a foundry manager of considerable experience, and past president of the local branch of the British Foundrymen's Association, has conducted a number of tests. The object was to ascertain whether in actual practice, with varying thicknesses of castings, the expansions followed in the same order as in my earlier experiments. The tests were made with a rectangular casting of special pattern. It was a frame, made with thin ends, and with one side much thicker than the other. It was cast in sand in the ordinary way, but arrangements were made for recording the

*See Hague & Turner "Influence of Silicon on Pure Cast Iron", *Journal of the Iron and Steel Institute*, 1910, Vol. II, p. 75.

changes of length of the two sides during cooling. It was found, as might be anticipated, that the expansions in the thin bar were similar to, and occurred in the same order as in the thick bar. But since the thin bar cooled more rapidly, its second expansion occurred while the thick bar was contracting after its first expansion. Hence while one side of the frame was expanding the other was contracting, and internal strains were set up in the casting. Positive and negative effects followed, until at length the thin side was uniformly contracting, after its third expansion, while the thick side was markedly expanding at about 700 degrees. As the metal is quite solid at such temperatures, the importance of the strains which are thus set up will be readily appreciated.

The arrests in the rate of cooling of a hot body, are obviously due to evolutions of heat at a given temperature or temperatures. These evolutions during cooling are merely the converse of heat absorptions during heating. A body which cools down in this irregular manner does not heat up uniformly. In practice it is much more easy to detect arrests during the cooling of a casting, than while heating up in the cupola. But there can be no doubt that the one is the converse of the other. If cast iron is chilled and the transformations are suppressed, heat is stored up in the solid. Hence it would save fuel in remelting if the iron were chilled as it comes from the furnace, instead of being cast in sand in the usual manner. The absence of sand on the surface is another incidental advantage. On the other hand the iron founder cannot judge of the character of the iron by fracture if it has been so chilled. It is also held, though I know not upon what scientific evidence, that metal which has been chilled retains some of its acquired hardness when remelted. It would scarcely be anticipated that such a result would follow, but it would be rash to contradict the opinion of a practical man without the support of a series of very carefully conducted tests.

An evolution of heat which causes an arrest in the rate of cooling, may be due to a change in state, as when a liquid is

converted to a solid, and parts with its latent heat of fusion. It may arise from an allotropic or polymorphic change, such as those which occur in pure iron, in iron sulphide, and many other substances. Thirdly, it may be due to the splitting up of a combination, the formation of which necessitated the absorption of heat. To this last class most of the changes which occur in cast iron belong.

Carbides Have Definite Composition

With carbon, iron unites to form carbides which are definite chemical compounds. Of these Fe_3C was first isolated by Abel and is well known: Fe_2C is also accepted, while the existence of Fe_4C and FeC is also suggested.

Within the range of ordinary furnace temperatures only Fe_3C need be considered. It is formed by the direct union of carbon and iron, with absorption of heat. It is more stable as the temperature rises. Hence at temperatures well above the melting point of cast iron it shows no tendency to decompose. But as the temperature falls the carbide tends to decompose into iron and carbon. Hence irons which are rich in carbon often yield graphite, in the form of "kish" when allowed to remain fluid just above their melting point. When only iron and carbon are present 4.25 per cent of carbon is retained in solution, and this solidifies as an iron, iron-carbide eutectic at about 1,130 degrees Cent. If the temperature falls rapidly the carbide may not have time to decompose, and white iron results. If, however, the cast iron is kept for a lengthened period at, or above, 1,000 degrees, the carbide decomposes and graphite is produced. The resultant is a gray iron, which may still contain carbide equal to 0.09 per cent of carbon. This residue may almost completely decompose, with further evolution of heat, at about 700 degrees Cent. One hundred volumes of carbide, if completely decomposed into iron and graphite expand to 113 volumes. The presence of silicon lowers the solubility of carbon, hence the total carbon is lower, and the formation of graphite is facilitated. The complete decomposition of the carbide is assisted by the pres-

ence of a small quantity of manganese. These facts will explain the two temperature arrests, and the two expansions observed with non-phosphoric gray cast irons.

Iron Phosphides

Iron and phosphorus unite to form several definite phosphides but only Fe_3P will be here mentioned. The phosphide becomes more stable as the temperature rises, hence steel cannot be dephosphorized if the temperature is too high.

The iron, iron-phosphide eutectic, which corresponds with the iron carbide eutectic, contains 10.2 per cent of phophorus and melts at 980 degrees Cent. In gray cast iron this binary eutectic combines with carbon to form a ternary eutectic, containing about 2 per cent of carbon, 6.7 per cent of phosphorus, and 91.3 per cent of iron. The triple eutectic solidifies at about 943 degrees Cent. and is the last portion of the casting to become solid. If the iron is very gray, the triple eutectic parts with its carbon, yielding graphite and the binary eutectic. The latter exists in the form of cells of irregular shape which are easily recognized under the microscope.

These facts account for the evolution of heat, and the expansion, which takes place with ordinary gray cast iron, at or somewhat above 900 degrees Cent.

While the three thermal reactions, just described, are undoubtedly the most important of those which occur during the heating or cooling of cast iron, there are others which are worthy of further investigation. We have for example the formation of silico-ferrite, and of silico-graphite, which appear to be of importance but of which little is known. There are also the reactions of manganese, and those of sulphur, both of which would doubtless repay further study. Though our knowledge of the subject has almost immeasurably increased during a generation, there are still untrodden fields for those who follow.

The Use of Borings in Cupola Operations

By James A. Murphy, Hamilton, O.

The melting of iron borings and even steel chips in the cupola for the double purpose of reducing mixture costs and bettering quality is not by any means a new theme for foundrymen to discuss, for in one form or another they have been successfully melted for many years, some methods being more successful and more economical than others.

About 30 years ago a patent was granted to Asa Whitney, of Philadelphia, covering a method of melting borings in wood boxes. This method is in use at the present day by some leading foundries and the results from a quality point of view seem to warrant its continuance. Many other methods are employed, some of which have been subjects of exploitation, and several patents of doubtful value have been granted. A number of the methods indicate an ignorance of the principles involved, while others are freakish, and not a few are pure fakes.

Melting Loose Chips is Unsatisfactory

The melting of chips loose in the cupola has been tried both alone and in combination with regular mixtures with very indifferent results. When melted alone the necessary heat will not penetrate the mass, the under and outer edges of the charge only being melted to varying depths depending on the quality of the fuel, the blast pressure and the thickness of the charge. When chips are charged promiscuously with the pig and scrap, the pyrotechnical display at the door and top of the cupola stack indicates the destruction of the elements of which they are composed. It is needless to say that both of these methods have long been abandoned. A few foundrymen, however, lay a thin bed of borings on the cupola bottom. The

melting iron coming down on the borings melts and absorbs them, but this is done at the expense of heat that may be badly needed by the iron. I consider this method for either chips or other small particles hazardous in the extreme where particular castings are made.

In the middle eighties a foundryman in Scranton, Pa., conceived the idea of filling old powder cans with these borings and charging them into the cupola the same as pig and scrap. The method was said to be very successful and was continued as long as the supply of old cans held out. For years, nothing was found for a substitute except wooden boxes.

Discovers Container by Accident

Along about 1904 Stanton Griffith, foundry superintendent of the Fairbanks-Morse Co., Beloit, Wis., was experimenting with the melting of borings in various kinds of containers, none of which were as satisfactory as Mr. Griffith desired. As Newton's discovery of the law of gravitation was accidental, so the method that I am going to describe was accidental to Mr. Griffith through the obstreperousness of a tomato can that found its way into the household furnace where it remained intact for some time, a decided obstacle to good and thorough combustion. Its remarkable state of preservation after going through the fierce fire that is necessary to keep a Beloit home warm and comfortable certainly classed it as an ideal container for melting borings, but as its size was against it a similar but larger can was made from regular lengths of stovepipe, crimping the can in at each end when full.

This method proved so successful that I was attracted by it, and from the results of several tests that I made, I concluded there was nothing better. I am still of the same opinion for long ago after much investigation I concluded that no other method gives as good, as economical or as reliable results.

Ten-Ton Heats Show Small Losses

These stovepipe lengths will hold about 50 pounds. It is preferable to use either a wood, iron or steel disk for the top or bottom of the cartridge. The containers can be filled at

the machines by machinists' helpers at very little if any cost as the borings must be taken away anyway. The cost of preparation for the cupola is about $2.50 per ton.

On three different occasions I melted 10 tons of these canned borings alone, using a blast pressure of from 9 to 10 ounces, our regular blast being from 14 to 16 ounces. All three of these heats showed a loss of less than 2 per cent, which seems remarkable. The charges were carefully weighed under my own supervision. A 10-ton ladle was weighed on a crane scales and then placed under the cupola spout, and when the contents of the cupola were run into it, it was weighed again with the results above mentioned.

The iron in each case was white and in no way fit for commercial machinery castings. It showed no tendency to stick to the ladle but was hot and fluid. A 6 x 6-inch section poured from the ladle was white all through, not a trace of graphitic carbon being visible near the center.

The melting of borings in cans or cartridges is being practiced by a large number of foundries engaged in both light and heavy work. There is no patent on the process and anyone is free to use it. It is beyond question a thoroughly successful method.

In 1908 a patent was granted to Mr. Walter F. Prince for melting borings in a vertical tube or casing having a higher melting point than the chips. The method at first was open to many serious objections, some of which have since been removed. Borings can be successfully melted by this method but it lacks what might be called mobility, as all the borings are only in one part of the cupola in a vertical column, with fuel only partly surrounding it, whereas with the cartridges, they can be distributed among the charge, giving a better mixture and insuring more even melting.

Briquetting is Not an Economical Method

The briquetting of borings by the German method, that is, subjecting them in suitable molds to great pressure, is a successful method but the cost is high and there is a considerable melting loss. It is said that the breaking or spalling of the

corners and edges of the briquettes represents a great loss. The briquetting of borings through the use of cement, canna pitch or any other wet binder is without question a great failure. The rapid generation of oxygen when moisture comes in contact with the borings soon leaves only a lump of rust to put in the cupola and when used in this way is productive of bad castings, as pin holes and so-called blow holes are prevalent. The melting loss by this method I found by experiment to reach as high as 60 per cent, while the resultant metal was bad. Castings poured with it for experimental purposes were very unsound and literally honeycombed with holes, while on the other hand castings poured from similar metal, taken from a ladle that was filled from the cartridges was sound all the way through and showed no signs of pin holes or any other unsoundness.

Summary

As a practical proposition the use of borings in binder bound briquettes is a failure. The briquettes made under enormous pressure are satisfactory, but the cost and melting loss is much higher than when melted in cans or cartridges. The tube method introduced by Mr. Prince has very narrow limitations as to the amount used, this being governed by the size of the tube which of necessity must be comparatively small. If a multiplicity of tubes is used, I think there is great danger of oxidation, as no fuel is underneath them. They can only be placed in one position in the cupola and that a specially prepared one on the side with a special door cut for the purpose. The attendant labor and waste of filling close to terrific heat is another objection.

With the cans or cartridges no extra labor is involved on the charging floor and the given amount to be put on any charge can be as evenly distributed throughout the charge as any component part of it. The cost of canning the borings exclusive of the labor of filling them is about $2.50 per ton. This filling labor should hardly be counted under most circumstances as the borings must be taken away from the machines and the helper may as well fill the cans as to use any other receptacles. Borings melted by this method are a decided

strengthener of castings and tend to give a closer grain. I have used them in various percentages in all kinds of work from the heaviest parts of high class machinery down to light automobile castings with unvarying beneficent results. The cost of wooden boxes is also about $2.50 per ton and the cost of tubes very little less. The cost of briquettes varies greatly. So many variables have to be taken into account and the method is so unreliable that it is not worth pursuing.

Discussion

THE CHAIRMAN, B. D. FULLER.—If there is nothing further, we will take up the next paper, "The Use of Borings in Cupola Operations," by Mr. James A. Murphy, Hooven, Owens & Rentschler Co., Hamilton, Ohio. Mr. Murphy apparently is not present. The subject is another thing with which many of us have had a varied experience, but you all have the paper and if you have any questions concerning it we may as well bring them up for discussion.

MR. W. J. DEAN.—I would like to ask if any one having had any experience using borings has had any trouble from shrinkage. I have tried to use them and had trouble from small shrinkage holes. I know a firm that is using them, about 6 or 7 per cent, and they have had no trouble at all. They are using the system of putting them in cans and placing them on the charge just the same as pigs. I have tried it in the same way, but always ran into trouble from shrinkage. I would like to know if any one else has had experience with borings in this particular.

MR. M. N. TABER.—We have used, in the last two years, about 250 tons of borings and have had no trouble with shrinkage. We combine them with a cementic material.

MR. W. J. DEAN.—Do I understand that you use it in the form of a briquette?

MR. M. N. TABER.—Yes.

Mr. S. D. Sleeth.—We have tried some simply by charging in a cast iron reservoir, but the trouble we find is that it hardens the iron. We put in a special heat and tried it out. I think we had 5,000 pounds total weight of reservoirs, and put in 3,500 pounds of turnings, and plugged the ends up. It was only a special test, and we had about 10 per cent melting loss. We tried briquetting without any binder and all of the tests we made showed a tendency to harden. In Pittsburgh we have a good market for borings and there is not so much inducement to try it out as in some places where there is no market. I tried the Prince method, Mr. Murphy speaks about in his paper, but we got white iron. I would like to find out from Mr. Murphy how he handles it. I do not understand about the method of using cans, whether he had to close the end.

The Chairman.—My understanding, from a reading of the paper, is that the ends are put on and hammered over.

Mr. W. J. Dean.—The way we used it, we took a piece of iron and curved it the same as a piece of stove pipe and then slit the ends about an inch apart right around and cut two discs slightly smaller than the can and crimped over one end, filled the can in the shop and put the other disc in and hammered down the other crimped end. That was the system we used and that was the same as they used in this shop where they are running successfully on 40-ton heats. They are using two or three tons each day. We could not do it without getting shrinkage holes in the casting. I sent some of the same castings to this shop and they made them successfully.

A Member.—Were you running high air pressure?

Mr. W. J. Dean.—About 12 ounces.

Mr. Kelly.—I am sorry Mr. Murphy is not here. I have been in his shop several times. His method of using the borings is to can them in the stove pipe. He cans them and holds them in place until they get down to the proper melting zone and melts them down. The man who throws his borings in loose is taking great chances.

The Chairman.—I might speak of my own experience with borings. Borings were shipped to us from Pittsburgh

to Cleveland in an open gondola car. I do not believe they were very carefully selected in the shop in the first place and they were considerably oxidized. We made transformers, light cast iron boxes, which we could not use and we utilized them by putting the borings in these scrap boxes and standing them upright in the center of the cupola and melting them down in that way, but the results were not very good. For instance, in motor bearings which we make in large quantities and finish, our losses were running normally on these, I should say, about 5 per cent and possibly heavier than that, after the returns from the machine shop came in, and while these castings did not show particular evidence of being dirty in the shop they did show more after using the borings; but when those borings got into the machine shop our losses jumped to 45 per cent on that particular casting. We immediately quit using borings, but the borings, as I have said before, were not high class. They looked to me like sweepings more than anything else and were considerably oxidized and not in good shape.

A Member.—We use borings every day. We use them in the vertical tube. We use about 5 per cent with very good success. We have no trouble with blow-holes, and use them for our machinery castings, such as cylinders, pistons and such things as have to be machined all over.

Mr. O'Hara.—We have been using successfully, for the last two or three years, from 4 to 6 tons of borings a day. We are using only our own borings so we are pretty well conversant with what is in them. We use a sheet iron box about 18 inches in diameter and about 8 inches deep. After testing a good many different methods, both briquettes and loose borings in cast iron cases, we have found the latter gives us by far the best results of anything we have tried. We feel in our case where we are using northern pig iron, it is of decided benefit. We get better results than with pure pig iron, and in our 48-inch cupola we use approximately 200 pounds to the charge. We use them on every charge within possibly the last two charges. We also use them in our bigger cupola, the metal from which is used for very heavy castings. We can stand more borings in the heavy castings.

Mr. G. E. Jones.—I would like to ask Mr. O'Hara if he has ever checked the melting loss before and after he started using the borings.

Mr. O'Hara.—Yes, we check our resultant loss every day. All of our charges are weighed in and checked up when weighed up, and we did that very carefully when we first started this method, and we have no more resultant loss from the use of the borings than we did before.

Mr. R. F. Harrington.—I would like to ask Mr. O'Hara if he ever noticed any shrinkage.

Mr. O'Hara.—No, except when we tested by using very large amounts of borings. They ran up to such an excessive amount that we got very poor results. You can get iron so hard that you can drop it on the floor and break it in two.

Mr. R. F. Harrington.—You never noticed anything in running 200 pounds on a 1,700-pound charge?

Mr. O'Hara.—No.

Mr. J. T. Kent.—We use borings all the time. We use about 100 pounds to a 2,500-pound charge. One day our purchasing agent thought he was going to save some money and he bought a lot of borings and the chemist thought he could use about 6 per cent borings and before we got him stopped we lost about 20 tons of pipe. We were making cast iron pipe. The bells came off, every one of them, shrunk off.

Mr. Lockpart.—Mr. Murphy is from my home town. There is no casting that he produces that is under about 300 pounds in weight. Most of his castings run as large as 10 tons, beds and flywheels. He has sublet all of his small work and we do his small work, and I know, although Mr. Murphy did not tell me, that the machine operators in his machine shop would rather have the castings coming from our foundry than machine the castings that he has made in his foundry. He uses quite an amount of borings and he uses the stove pipe for it. He has that setting under each machine and each man has to take his own borings and they are put on a big truck and run over to the foundry and charged, but he can get away with that for the simple reason that he makes no light work.

Dr. Richard Moldenke.—I regret very much to differ with Mr. Murphy on some of his facts and conclusions derived in

connection with the use of cast borings in foundry practice. Unquestionably all the methods he enumerates will give good results if operated under correct melting methods, and all of them will give bad results if the charging method is bad, the cans, briquettes or stove-pipes become damaged and allow loose borings to drop into the bed and before the tuyeres.

Mr. Murphy's estimate of the cost of the several processes is not altogether correct, as while he may be right about wooden boxes and his cartridges at $2.50 a ton ready for charging into the cupola, the method of Mr. Prince costs no more than $1.50 a ton (exclusive of royalty) and that of briquetting under high pressures about the same. The two last mentioned methods give good results, as does Mr. Murphy's can method, where medium and heavy castings are the rule, and these will machine nicely and without blow-holes if the charging and melting has been done right. For very light castings, however, particularly where high speed machining is essential, no process of using cast borings will fill the bill, as the melting of material so prone to oxidation as this is bound to harden the metal. The mistake made in introducing both the tube and the briquetting methods into foundries has been in going to specialty shops machining enormous numbers of very light castings. Here the saving in the mixture is more than offset by the extra cost of machining, and it does not pay.

For general work, as stated, the three methods work out all right if carried out right. Mr. Murphy's can method costs most, Mr. Prince's is cheaper but has a disadvantage of the tubes opening up and spilling the borings if in careless hands. The briquettes under high pressure work all right if not made too large in cross-section and if the pressure is sufficiently high. That Mr. Murphy's conclusion in regard to briquettes that "the method is so unreliable that it is not worth pursuing" is entirely incorrect is shown by the fact that today there are 25 high pressure briquetting plants in Europe in full operation and supplying hundreds of foundries with their borings in briquette form. In this country the cost, including royalty, will run between $1.25 and $2.00 a ton, depending upon the weight of borings compressed at each impulse.

A further criticism I must make is in regard to Mr. Murphy's remarkable tests in melting canned borings, his loss being less than 2 per cent. I cannot accept this as possible, and rather judge that some error in manipulation has escaped Mr. Murphy's attention. I have had many samples of cast borings analyzed for their iron content. The very best of them—sold at a premium for their comparative freedom from extraneous matter—gave less than 90 per cent actual iron. Ordinarily, cast borings run nearer 85 per cent iron than 90. This accounts for the comparatively poor reports obtained when any process of melting borings, whether in can, tubes or as briquettes, is carried out, using borings only. These results show from 12 to 20 per cent loss in melting, but it is forgotten that from 10 to 15 per cent of the borings was not iron in the first place.

Again, any rusting from exposure of the borings before canning or briquetting means just so much iron removed from the possibility of melting, as iron oxide (rust) goes into the slag.

In view, therefore, of the importance of saving values, the use of borings should be encouraged, but in their proper place. It will pay foundrymen making medium and large castings, and small castings not requiring machining, to look into the matter carefully, as economy will soon be the order of the day. The European foundrymen have done so, and the briquetting process, under very high pressure, seems to have filled the requirements best, as the tube, can and other methods of introducing borings in their loose form have not remained live issues.

The Application of the Match-Plate to Foundry Work

By J. K. Grill, Chicago

With the rapid development of improved molding machinery, its adoption as a mechanical aid and its substitution for hand methods, the foundryman has been able to reduce his molding cost which is the major item of foundry expense. On specialized or repetition work, the semi-automatic methods of molding have been employed effectively.

In the evolution and application of the various methods of molding, we find the match-plate an established and reliable asset to the foundry and which is in use daily in the production of a large variety of castings.

The double-face match-plate affords many advantages as compared with the molding methods practiced with the single or carded hand patterns and loose matchboard.

In adapting the match-plate to foundry work, care should be exercised in the selection and arrangement of the particular class of patterns to be mounted, and to satisfy all conditions the following factors should be taken into account:

1.—Quantity of castings required.
2.—Cost of making the equipment.
3.—Particular design of pattern.
4.—Uniformity in weight of castings.
5.—Flask area.
6.—Maximum production, floor area per foot.
7.—Cheap production.

Quantity of Castings Required

The annual requirements of a certain line of casting is a factor controlling the type of mounting adopted. The quantity of castings required should be large enough to warrant the expense of making the match-plate.

The cost of manufacturing the match-plate varies with the particular design of the pattern and usually is in excess of hand pattern costs.

Since the introduction of the various aluminum alloys and on account of their lightness, they are being used almost universally in the making of the match-plates. For plates having straight or flat partings and where patterns can be machined and finished before attaching to the plate, rolled aluminum, 1/4 to 3/8 inch in thickness, or steel plates 1/8 to 3/16 inch in thickness, copper-covered, are used.

A considerable saving can be effected by the skill and care exercised by the molder in making proper partings on the plates so that no back-draft or undercut appears on the pattern lines, or angles of recesses are too acute; the proper chilling of metal in heavy parts to avoid excessive shrinkage also must have consideration.

The molder should be supplied with a metal flask, well machined and pinned so as to avoid any possibility of shift in the mold. A match-plate, once cast in a shifted mold, cannot be corrected and must be rejected as a loss.

In making a plate where more than one pattern is to be mounted, the master patterns should be string-gated to avoid ramming them out of place and also to enable the molder to rap the patterns through the cope; this gives a uniform rap to all of the patterns on the gate in the cope and drag mold at the same time, thereby avoiding troublesome shifts in cast plates.

To obtain the best results in making the plate, the drag mold should be sprayed and skin-dried, if cast of aluminum. The aluminum should be melted in a crucible to melting heat only and then should be poured into a heated iron ladle and fluxed with a small quantity sal-ammoniac; it should be well skimmed before pouring.

After a series of tests of the aluminum alloys best suited to meet all requirements for match-plates, the following mixture was adopted: Copper, from 3 to 4½ per cent; zinc, from 13 to 16 per cent, and balance, aluminum.

The difficulties encountered in soldering aluminum have been disadvantageous to some foundries in adopting the match-

plate molding process. While there are many solders and fluxes on the market, a solder giving satisfactory results can be made from the following mixture: 23 per cent lead, 33 per cent zinc and 44 per cent tin. This solder can be applied without the use of a flux and by the ordinary copper soldering iron. After the aluminum is once tinned with this solder any solder can be applied in the regular way.

Particular Design of Patterns

The particular design of the pattern is often the deciding factor in the economy of mounting it on the plate. If the design is such that deep pockets or sharp recesses and very irregular partings appear on the flask lines and require a cut flask or hand-ramming, this type of pattern had better be left to be mounted on the machine or handled otherwise.

On patterns with round or cylindrical sections some difficulty in molding has been experienced due to shifts, or ram-offs appearing on match lines. This objectionable feature, so pronounced on castings of this type produced on the match-plate, has been met by designing the plate with a well-arched cope, about 1 inch high, with edges about 25 per cent tapering to flask lines. The flat or arched portion should be the overall dimensions of the patterns on the plate. This feature on a plate aids in aligning the cope and avoids a shifted mold. The flask area of this class of casting should be large enough to avoid the necessity of boxing the mold, as the practice of boxing aids and is often the cause of shifted molds. A further precaution to avoid ram-offs on round section patterns on plates is to have the molder cut a small groove, 3/16 to ¼ inch deep on the plate around the pattern line parallel with the patterns and as close to the patterns as molding conditions will permit. The cause of shifts or ram-offs often is traced to too high a squeeze causing bowed plates.

Uniformity in Weight of Castings

Uniformity in weight of castings produced by the match-plate and vibrator molding method as compared with the hand rapping and hand drawing is deserving of attention. On small and

medium-size castings, such as are used on agricultural machinery, and where there is a high ratio of surface area to total weight, an estimated saving in material of 10 to 20 per cent is made, due to the uniformity of the mechanical rap and simplified pattern-drawing methods of the match-plate. The defect in overweight of castings is not only a loss in material but adds to the machine department labor costs in spoiled work or improperly machined castings because castings will not fit their jigs or fixtures without the application of additional labor.

Flask Area

The area of a flask defines the limits of the economical squeeze ram. On light or medium class of work, the use of shallow flasks ranging in area of 1 square foot or 12 x 12 inches, to 1¾ square feet or 12 x 21 inches, come within the practical limits of squeeze ram on hand or power squeezers. In a power squeezer the capacity of a 10-inch cylinder with 70 to 80 pounds per square inch pressure, will successfully ram flasks ranging in area up to 1¾ square feet. The use of flasks larger than these sizes and where bars are necessary would require a squeezer too heavy or cumbersome and would not be considered a squeezer proposition in connection with the match-plate.

Maximum Production Per Foot of Floor Area

The application of the match-plate in the production of light and medium weight castings offers a maximum output with a corresponding saving in floor space. The several advantages in the arrangement of the patterns on a plate in relation to the gating problem are: First, hand patterns must of necessity have as many and large enough gates to support each individual pattern on the runner bar in order to avoid the sagging of the patterns while drawnig them out of mold, while the patterns on plate can have the gates shaped, sized and arranged with respect to the successful running of the castings only. Second, in many cases a larger number of patterns can be arranged on a

plate without a corresponding increase in flask area used on hand patterns due to regating advantages of a plate as compared with a gated hand pattern.

Cheap Production

Due to the possibilities of trimming or sizing the gates on plated patterns, an estimated saving of 25 to 30 per cent sprue remelt can be made. By the application of the match-plate, molders' spoiled work or scrap can be cut down 10 to 15 per cent; economy of 25 per cent in floor area can be effected; the production can be increased 20 to 30 per cent; pattern repairs can be eliminated almost entirely and unskilled labor can be employed.

The Effects of Different Mixtures on the Strength of Chilled Car Wheels

By G. S. Evans, Lenoir City, Tenn.

Some seven years ago the Lenoir Car Works purchased an adjacent wheel foundry known as the Bass foundry. Immediately afterward the new management built a chemical laboratory and equipped it with the necessary apparatus for analyzing and testing its raw and finished products, both chemically and physically. A chemist was employed and experiments were commenced with a view first, to improve the strength of the wheels; secondly, to improve on the methods of procedure, and finally, to reduce the cost of manufacture.

After taking stock of all material on the yard and making a chemical analysis of each car or pile of pig iron, scrap wheels and scrap steel, we began to figure the cupola charges on the analysis basis, instead of by fracture as before, and immediately we were able to produce a more uniform metal and consequently uniformly stronger wheels. Next followed changes in the mixture, including addition of scrap steel and malleable in place of No. 6 charcoal pig, using larger percentages of higher silicon irons. Small additions of steel were found to materially increase the strength of the wheels as shown by the drop test; the proportion of steel was gradually increased as long as any improvement was noticeable until we were using approximately 10 per cent in the mixture, with a corresponding reduction in the amount of pig iron.

High Priced Pig

At that time charcoal pig iron was costing $24 per ton as against $12 for the steel scrap, so that the increased percentage of steel in the mixture not only increased the strength of the wheel but materially reduced the cost of the mixture. This suggested the probability of further cheapening our mixture, and experiments were begun with this end in view.

A test cupola was provided and sample cars of several brands of southern coke iron as well as some of the cheaper brands of northern charcoal irons were purchased and melting tests were made of these as compared to the southern charcoal irons which we were using. These tests showed:

First, that the northern charcoal irons and some of the brands of coke irons were equally as strong as the southern charcoal irons.

Second, that with the intelligent use of scrap steel the chilling qualities of either could be controlled at will.

Third, that the strength of the melt was dependent more on the method of melting, that is on the cupola practice, than on the strength of the iron in its original state.

With these facts before us we began gradually to replace the southern charcoal irons that we were using with northern charcoal and southern coke irons, and at the same time to devote more attention to our melting practice, carefully watching all along the strength of the finished wheels. Strange as it may seem, especially to the advocates of charcoal iron, the daily tests showed that the strength of the wheels was gradually increasing from week to week, and when finally all charcoal irons were eliminated from the mixture we were making stronger wheels than at any previous time. Whereas previously we had realized the possibility of a failure, we now were able to guarantee our wheels to withstand treble the number of blows under the drop test required by the Master Car Builders' specifications, or we could permit a 2½-inch instead of a 1½-inch band of molten iron in the thermal test.

As stated, the strength of the wheels gradually increased and was greater after we had finally replaced all of the higher grade charcoal with cheaper coke iron, with a very noticeable reduction in the cost of the mixture. This greater strength resulted not from changes in the mixture, but from better foundry practice, especially from improvements in melting and annealing.

Satisfactory Results Obtained

Practically all of our output of wheels is consumed by one railway system, and when word reached the head of the mechanical department of this system that we were no longer

using any charcoal iron, he began to make an investigation, comparing our wheels with other makes. However, it appeared that our product compared very favorably with other brands, and that they greatly exceeded in strength the requirements of the Master Car Builders' specifications.

Then the probability as to whether, with our existing foundry practice, a still stronger or better cast iron wheel could be produced by the use of charcoal iron, suggested itself alike to the railway officials and the management of our company. With this in view an extended series of comparative tests were made to determine the relative strength of wheels made from mixtures containing different percentages of coke and charcoal irons, when made under uniform foundry conditions.

During these tests, which lasted over a period of more than two years, wheels were cast from 60 different mixtures, some of which carried as much as 60 per cent scrap steel; others contained 85 per cent charcoal and coke pig, and still others as much as 98.5 per cent scrap wheels. It was found that wheels could be made from all these mixtures that would meet the requirements of the latest Master Car Builders' Association specifications. Over 15,000 wheels were cast from the special mixtures, of which more than 1,000 were tested to destruction according to the Master Car Builders' drop and thermal tests and the Lobdell flange test.

This paper presents in detail the results of the conclusive series of comparative tests. It is presented only as experimental data, not with the purpose of influencing other manufacturers against the use of charcoal iron, but solely for the purpose of giving the results of our labors to the public, which we hope will in some small way help toward general improvement in cast iron wheels.

This series of tests consisted of nine different mixtures, each of which were run for two or more successive heats, casting several hundred wheels from each, from which the test wheels were selected. Twenty wheels were tested from each mixture, 10 each under the Master Car Builders' drop and thermal tests. The results were tabulated.

The results of the tests including, besides the drop and thermal tests, chemical analyses, transverse strength of chilled and gray iron bars, and Brinell hardness of both the unannealed chilled bar and the chilled and gray portion of annealed wheels, are shown in Tables I to IX. A summary of the average results are shown in Table X.

Micrographs Were Made

Micrographs were made of specimens from the chilled surface and gray portion (single plate) of two or more representative wheels from each of the nine different mixtures and of the unannealed chilled test bars. The appearance of the chilled surfaces of the wheels at 150 magnifications, unetched and etched with picric acid, are shown in Figs. 1A to 9A and 1B to 9B. The details of the plate or gray portions of the wheels at 100 magnifications, unetched and at 250 magnifications etched with picric acid are shown in Figs. 1C to 9C and 1D to 9D. The unannealed test bars at 150 magnifications, unetched and etched with picric acid, are shown in Figs. 1E to 9E and 1F to 9F.

As previously stated, this investigation was begun with a view of determining whether by changing the present cupola mixture it was possible to produce a better cast iron wheel than our present standard which, as shown in Table I, already far exceeds in strength the requirements of the Master Car Builders' drop and thermal tests. Studying the summary of the results of the tests, Table X, it will be noticed that wheels from our standard mixture compare favorably with wheels from any of the mixtures shown. These data, taken in connection with our general investigation of the subject, preceding this series of tests leads us to the following conclusions:

No gain in strength is obtained by increasing the percentage of either charcoal or coke pig iron beyond approximately 12 per cent, that is beyond our present standard.

The substitution of charcoal pig for coke pig iron does not result in any clearly defined beneficial effects in the strength of the wheels as shown by the Master Car Builders' drop and thermal tests and the Lobdell flange test.

The effects, if any, of the different mixtures on the micro-structure of either the chilled or gray portions of the finished wheels is not of such a nature as to be clearly defined. This is a result rather of the chemical analysis and foundry practice than of the original character of the melt.

The foundry practice, including the melting, casting and annealing, appears to be largely responsible for the ultimate strength of the finished wheels, and the greatest possible source of betterment of the output as a whole, results from the standardization of foundry practice for the purpose of bringing more nearly up to the average strength that portion of each cast which is now subnormal.

Notes

These remarks apply to all tables.

*Carbon determined by color.

†By difference.

‡By direct combustion.

The analyses were made from mixed drillings from five wheels.

The Brinell hardness, single plates, is an average of tests on five wheels.

The hardness of the surface of the chilled tread is an average of tests on two wheels.

The hardness of the surface of the chilled test ingot is an average of tests on five ingots.

The transverse strength is an average of eight bars.

DETAILS OF THE MIXTURES AND OF INDIVIDUAL WHEELS TESTED, TOGETHER WITH AVERAGE ANALYSES OF WHEELS FROM EACH MIXTURE

Table I

MIXTURE NO. 1

Standard or Regular Mixture

	Per Cent
Southern Coke Pig Iron	11.60
Steel Scrap	8.30
Scrap Wheels	80.00
Ferro-Manganese	0.20

Analysis

	Per Cent
Silicon	0.607
Sulphur	0.148
Manganese	0.563
Phosphorus	0.430
Combined Carbon*	0.729
Graphitic Carbon†	2.587
Total Carbon‡	3.316

Drop and Thermal Tests

No.	Tape	Drop Tests Blows to Crack	Break	Chill inch	No.	Tape	Thermal Tests Time to Crack Min.	Sec.
10077	2	32	53	1/2 —5/8	10076	2	2	12
10079	2	28	69	1/2 —9/16	10080	2	2	33
10084	2	44	89	1/2 —5/8	10086	2	6	50
10091	2	6	87	1/2 —5/8	10116	2	3	40
10117	2	36	107	3/8 —1/2	10118	2	5	20
10128	2	20	62	1/2 —5/8	10127	2	3	55
10341	2	25	33	1/2 —1/2	10340	2	2	41
10348	2	30	47	3/4 —7/8	10347	2	2	21
10359	2	25	53	7/16—1/2	10358	2	2	8
10368	2	30	62	1/2 —5/8	10367	2	4	55
Average.....		27.6	66.2	0.51 0.60			3.65	

Brinell Hardness

Section of single plates	150
Surface of chilled tread	477
Surface of chill test ingot	482

Transverse Strength

	Load Lbs. per sq. in.	Deflection inch
1¼-inch Round Bar	2958	0.123
1⅛-inch Square Bar—chilled	2611	0.043

Table II

MIXTURE NO. 2

Standard or regular mixture with the coke pig iron replaced with charcoal.

	Per Cent
Charcoal Pig Iron	13.30
Steel Scrap	8.30
Scrap Wheels	78.30
Ferro-Manganese	0.05

Analysis

	Per Cent
Silicon	0.634
Sulphur	0.160
Manganese	0.425
Phosphorus	0.350
Combined Carbon	0.344
Graphitic Carbon	3.191
Total Carbon	3.535

Drop and Thermal Tests

		Drop Tests Blows to					Thermal Tests Time to Crack	
No.	Tape	Crack	Break	Chill inch	No.	Tape	Min.	Sec.
13008	2	25	67	7/16—9/16	13009	2	3	50
13010	2	17	69	1/2 —9/16	13011	2	7	37
13028	2	15	50	7/16—1/2	13029	2	2	35
13030	2	19	45	7/16—9/16	13031	2	3	25
13032	2	13	70	7/16—1/2	13033	2	3	12
13250	2	18	42	7/16—9/16	13232	2	3	10
13252	2	14	43	7/16—1/2	13251	2	4	10
13254	1	9	45	7/16—1/2	13253	1	1	48
13256	1	14	32	1/2 —5/8	13255	1	2	30
13276	1	10	32	1/2 —5/8	13270	1	2	30
Average.....		15.4	49.6	0.46 0.56			3.50	

Brinell Hardness

Section of single plates	125
Surface of chilled tread	457
Surface of chill test ingot, unannealed	478

Transverse Strength

	Load Lbs. per sq. in.	Deflection inch
1¼-inch Round Bar—gray	2975	0.111
1⅛-inch Square Bar—chilled	2617	0.043

Table III

MIXTURE NO. 3

Standard or regular mixture except one-half of the coke pig iron replaced by charcoal pig iron.

	Per Cent
Charcoal Pig Iron	6.60
Coke Pig Iron	6.60
Steel Scrap	8.30
Scrap Wheels	78.30
Ferro-Manganese	0.10

Analysis

	Per Cent
Silicon	0.630
Sulphur	0.148
Manganese	0.460
Phosphorus	0.380
Combined Carbon	0.452
Graphitic Carbon	3.034
Total Carbon	3.486

Drop and Thermal Tests

No.	Tape	Drop Tests Blows to Crack	Drop Tests Blows to Break	Chill inch	No.	Tape	Thermal Tests Time to Crack Min.	Thermal Tests Time to Crack Sec.
15111	2	40	76	5/16—7/16	15110	2	2	23
15131	3	20	74	5/16—7/16	15127	2	2	54
15133	2	20	71	7/16—1/2	15132	3	5	00
15095	3	20	82	7/16—9/16	15135	3	4	40
15097	3	33	80	7/16—9/16	15096	3	2	30
15115	2	28	87	7/16—1/2	15098	2	3	00
15118	2	41	63	1/2 —9/16	15116	2	2	00
15134	2	23	59	1/2 —5/8	15119	2	1	35
15138	2	38	80	1/2 —5/8	15120	2	2	41
15140	2	10	46	7/16—9/16	15139	2	2	20
Average.....		27.3	71.8	0.43 0.54			2.91	

Brinell Hardness

Section of single plate	121
Surface of chilled tread	460
Surface of chill test ingot, unannealed	493

Transverse Strength

	Load Lbs. per sq. in.	Deflection inch
Gray Iron Bars	2865	0.129
Chilled Iron Bars	2672	0.052

Table IV

MIXTURE NO. 4

Standard or regular mixture except all scrap wheels were of the shop's own product and had previously been made from the standard mixture.

	Per Cent
Coke Pig Iron (Southern)	13.30
Steel Scrap	8.30
Scrap Wheels (Lenoir Make)	78.30
Ferro-Manganese	0.20

Analysis

	Per Cent
Silicon	0.611
Sulphur	0.135
Manganese	0.545
Combined Carbon	0.443
Graphitic Carbon	2.222
Total Carbon	2.665
Phosphorus	——

Drop and Thermal Tests

		Drop Tests					Thermal Tests	
		Blows to		Chill			Time to Crack	
No.	Tape	Crack	Break	inch	No.	Tape	Min.	Sec.
12393	2	30	49	7/16—1/2	12392	1	2	00
12395	2	28	45	5/16—7/16	12394	2	1	56
12402	2	26	46	7/16—1/2	12401	2	1	42
12409	1	19	27	1/2 —5/8	12408	2	1	46
12412	2	22	38	7/16—1/2	12413	2	1	58
12414	2	15	31	1/4 —3/8	12415	2	1	59
12422	2	14	32	5/16—1/2	12423	2	1	55
12434	3	58	93	3/8 —1/2	12433	3	2	28
12437	2	41	59	1/2 —5/8	12435	3	2	42
12440	3	26	40	5/16—7/16	12439	2	2	00
Average.....		27.9	46.0	0.38 0.50			2.05	

Brinell Hardness

Section of single plate	141
Surface of chilled tread	474
Surface of chill test ingot, unannealed	512

Transverse Strength

	Load Lbs. per sq. in.	Deflection inch
Gray Iron Bars	2991	0.125
Chilled Bars	2619	0.049

Table V

MIXTURE NO. 5

Standard or regular mixture, except that all scrap wheels were of the shop's own product and had been previously made from the standard mixture, using charcoal pig iron.

	Per Cent
Charcoal Pig Iron	13.30
Steel Scrap	8.30
Scrap Wheels (Lenoir Make)	78.30
Ferro-Manganese	0.10

Analysis

	Per Cent
Silicon	0.640
Sulphur	0.128
Manganese	0.440
Phosphorus	——
Combined Carbon	0.475
Graphitic Carbon	2.966
Total Carbon	3.441

Drop and Thermal Tests

No.	Tape	Drop Tests Blows to Crack	Break	Chill inch	No.	Tape	Thermal Tests Time to Crack Min.	Sec.
15327	2	30	63	3/8 —7/16	15329	2	1	52
15330	2	43	70	5/16—7/16	15331	2	2	00
15347	2	21	67	3/8 —1/2	15345	2	2	43
15439	2	23	61	3/8 —7/16	15348	2	1	35
15360	2	17	46	1/2 —9/16	15350	2	2	00
15363	2	28	53	3/8 —7/16	15361	2	2	5
15365	2	23	46	3/8 —7/16	15364	2	2	10
15367	2	32	60	3/8 —7/16	15366	2	1	49
15369	2	12	34	1/4 —7/16	15368	2	1	50
15373	2	19	38	3/8 —1/2	15371	2	2	5
Average.....		24.8	53.8	0.36 0.46			2.01	

Brinell Hardness

Section of single plate	114
Surface of chilled tread	470
Surface of chill test ingot, unannealed	500

Transverse Strength

	Load Lbs. per sq. in.	Deflection inch
Gray Iron Bars	2845	0.115
Chilled Bars	2758	0.052

Table VI

MIXTURE NO 6

Special high coke pig iron mixture, using 20 per cent pig.

	Per Cent
Coke Pig Iron	20.00
Steel Scrap	13.30
Scrap Wheels	66.50
Ferro-Manganese	0.20

Analysis

	Per Cent
Silicon	0.602
Sulphur	0.131
Manganese	0.560
Phosphorus	0.530
Combined Carbon	0.883
Graphitic Carbon	2.351
Total Carbon	3.234

Drop and Thermal Tests

No.	Tape	Drop Tests Blows to Crack	Drop Tests Blows to Break	Chill inch	No.	Tape	Thermal Tests Time to Crack Min.	Thermal Tests Time to Crack Sec.
15954	2	29	37	3/8 —7/16	15955	2	3	00
15956	2	32	54	7/16—9/16	15958	2	3	18
15960	2	22	41	7/16—1/2	15959	1	2	35
15971	1	38	64	7/16—1/2	15968	2	2	18
15975	2	23	39	5/8 —3/4	15974	2	2	8
15980	1	21	42	5/8 —3/4	15979	1	2	17
15990	2	27	40	3/8 —7/16	15989	2	3	00
15995	2	18	27	7/16—1/2	15991	2	2	16
15998	2	25	41	9/16—5/8	15997	2	2	25
16000	2	22	37	9/16—11/16	15999	2	2	20
Average.....		25.7	42.2	0.49 0.58			2.57	

Brinell Hardness

Section of single plate	152
Surface of chilled tread	464
Surface of chill test ingot, unannealed	482

Transverse Strength

	Load Lbs. per sq. in.	Deflection inch
Gray Iron Bars	2378	0.050†
Chilled Bars	2850	0.057

†Bars mottled.

Table VII

MIXTURE NO. 7

Special high coke pig iron mixture using 30 per cent pig.

	Per Cent
Coke Pig Iron	30.00
Steel Scrap	13.30
Scrap Wheels	56.60
Ferro-Manganese	0.25

Analysis

	Per Cent
Silicon	0.588
Sulphur	0.134
Manganese	0.535
Phosphorus	0.580
Combined Carbon	0.643
Graphitic Carbon	2.565
Total Carbon	3.208

Drop and Thermal Tests

		Drop Tests Blows to					Thermal Tests Time to Crack	
No.	Tape	Crack	Break	Chill inch	No.	Tape	Min.	Sec.
16450	2	26	46	3/8 —1/2	16646	2	1	41
16452	2	38	51	3/8 —1/2	16451	2	1	37
16471	1	12	33	1/2 —9/16	16470	2	3	00
16473	1	32	47	5/8 —3/4	16472	1	2	18
16480	1	25	42	1/2 —9/16	16479	1	1	45
16482	1	28	44	1/2 —9/16	16481	1	1	49
16491	2	15	30	1/2 —5/8	16490	2	2	12
16493	2	26	39	1/2 —5/8	16494	2	2	40
16498	2	19	30	1/2 —5/8	16499	1	2	10
16500	2	25	46	1/2 —9/16	16501	2	2	8
Average.....		24.6	40.8	0.49 0.59			2.13	

One wheel broke through tread in 3.06 minutes.

Brinell Hardness

Section of single plate	145
Surface of chilled tread	460
Surface of chill test ingot, unannealed	495

Transverse Strength

	Load Lbs. per sq. in.	Deflection inch
Gray Iron Bars	2235	0.043†
Chilled Bars	2846	0.058

†Bars mottled.

Table VIII

MIXTURE NO. 8

Special high charcoal pig iron mixture using 20 per cent pig.

	Per Cent
Charcoal Pig Iron	20.00
Steel Scrap	10.00
Scrap Wheels	70.00
Ferro-Manganese	0.10

Analysis

	Per Cent
Silicon	0.611
Sulphur	0.142
Manganese	0.470
Phosphorus	0.300
Combined Carbon	0.453
Graphitic Carbon	3.050
Total Carbon	3.504

Drop and Thermal Tests

No.	Tape	Drop Tests Blows to Crack	Break	Chill inch	No.	Tape	Thermal Tests Time to Crack Min.	Sec.
13470	2	27	61	7/16—1/2	13471	2	1	45
13472	2	31	59	1/2 —9/16	13478	2	2	00
13490	2	42	77	7/16—9/16	13491	2	4	20
13493	1	16	53	1/2 —5/8	13494	1	3	20
13495	1	21	54	9/16—11/16	13496	1	2	19
13697	1	29	46	1/2 —5/8	13698	1	2	45
13700	2	30	48	7/16—9/16	13701	2	2	20
13702	2	50	78	1/2 —9/16	13703	2	1	21
13719	1	17	29	9/16—11/16	13720	1	2	00
13739	1	26	43	5/8 —3/4	13740	1	2	20
Average.....		28.9	54.8	0.51 0.61			2.45	

Brinell Hardness

Section of single plate	115
Surface of chilled tread	460
Surface of chill test ingot, unannealed	511

Transverse Strength

	Load Lbs. per sq. in.	Deflection inch
Gray Iron Bars	2735	0.100
Chilled Bars	2719	0.054

Table IX

MIXTURE NO. 9

Special high charcoal pig iron mixture using 30 per cent pig.

	Per Cent
Charcoal Pig Iron	30.00
Steel Scrap	11.60
Scrap Wheels	58.30

Analysis

	Per Cent
Silicon	0.599
Sulphur	0.123
Manganese	0.400
Phosphorus	0.290
Combined Carbon	0.421
Graphitic Carbon	3.088
Total Carbon	3.509

Drop and Thermal Tests

No.	Tape	Drop Tests Blows to Crack	Drop Tests Blows to Break	Chill inch	No.	Tape	Thermal Tests Time to Crack Min.	Thermal Tests Time to Crack Sec.
14169	1	17	33	1/2 — 5/8	14168	2	1	14
14190	0	12	41	11/16—13/16	14191	0	1	48
14210	1	20	66	9/16—11/16	14195	1	1	46
14212	1	27	82	11/16— 3/4	14211	1	2	56
14215	1	15	26	5/8 — 3/4	14213	2	1	45
14423	2	25	56	7/16— 7/16	14214	1	2	00
14425	1	18	36	1/2 — 5/8	14424	1	1	32
14443	2	17	48	7/16— 9/16	14427	2	1	48
14445	2	23	58	3/8 — 1/2	14444	2	3	15
14447	2	15	60	7/16— 1/2	14446	2	2	20
Average.....		18.9	50.6	0.52 0.62			2.05	

Brinell Hardness

Section of single plates	118
Surface of chilled tread	468
Surface of chill test ingot, unannealed	491

Transverse Strength

	Load Lbs. per sq. in.	Deflection inch
Gray Iron Bars	2900	0.097
Chilled Bars	2656	0.052

Table X

SUMMARY OF RESULTS OF PHYSICAL TESTS OF CAST COAL AND SOUTHERN COKE PIG IRON WITH HARDNESS TESTS OF BARS FROM THE AT THE WHEEL FOUNDRY

Mixture	Chill in Tread inches	Drop Test Blows to Crack	Drop Test Blows to Break
Series No. 1.—Comparison of wheels from the regular Coke pig iron mixture to wheels made from the same modified by replacing—1st one-half and 2nd all of the Coke pig wth charcoal pig iron—			
1.—Wheels from regular Coke iron mixture	0.60	27.6	66.2
2.—Same except all of Coke iron replaced with Charcoal pig iron	0.56	15.4	49.6
3.—Same as No. 1 except one-half Coke iron replaced with Charcoal pig iron	0.54	27.3	71.8
Series No. 2.—Comparison of wheels from the regular mixture (as above) to wheels made from like mixtures except using only scrap wheels that had previously been made from the shop's own regular mixture using coke pig iron—			
1.—Wheels from regular coke pig iron mixture	0.60	27.6	66.2
4.—Same except scrap wheels used in the mixture all of Lenoir make	0.50	27.9	46.0
5.—Same as No. 4 except using Charcoal pig iron	0.46	24.8	53.8
Series No. 3.—Comparison of wheels made from mixtures containing 12 per cent, 20 per cent and 30 per cent of Coke and Charcoal pig irons respectively—			
1.—12 per cent Coke pig iron mixture (regular mixture)	0.60	27.6	66.2
2.—12 per cent Charcoal iron mixture—the regular mixture except replacing coke iron by charcoal pig iron	0.56	15.4	49.6
6.—20 per cent Coke iron mixture	0.58	25.7	42.2
7.—20 per cent Charcoal iron mixture	0.61	28.9	54.8
8.—30 per cent Coke iron mixture	0.59	24.6	40.8
9.—30 per cent Charcoal iron mixture	0.62	18.9	50.6

All wheels were M. C. B. standard 33 inches diameter, weight 675 pounds.

Notes.—Chill—Depth of clear white iron in center of the tread, in inches, average of 10 wheels.

Drop Tests.—With 200-pound ball falling 12 feet.—First, average number of blows to produce the first crack; second, to break in two pieces. Average of 10 wheels.

Thermal.—2⅜-inch band of molten iron cast around the tread—average number of minutes before first crack appears in the plates, 10 wheels.

Table X

IRON WHEELS MADE FROM LIKE MIXTURES OF CHAR-
A SUMMARY OF TRANSVERSE STRENGTH AND
DIFFERENT MIXTURES. TESTS MADE
OF THE LENOIR CAR WORKS.

Thermal Tests Time to Crack Minutes	Brinell Hardness Plate	Tread	Ingot	Transverse Strength Gray Iron 1¼ Inches Round Lbs. per Sq. In.	Deflection Inches	Chilled Bars 1⅛ Inches Square Lbs. per Sq. In.	Deflection Inches
3.65	150	477	482	2958	0.123	2611	0.043
3.50	125	457	478	2975	0.111	2617	0.043
2.91	121	460	493	2865	0.129	2672	0.052
3.65	150	477	482	2958	0.123	2611	0.043
2.05	141	474	512	2991	0.125	2619	0.049
2.01	114	470	500	2845	0.115	2758	0.052
3.65	150	477	482	2958	0.123	2611	0.043
3.50	125	457	478	2975	0.111	2617	0.043
2.45	152	464	482	....	....	2850	0.057
2.45	145	460	495	....	....	2846	0.058
2.13	115	460	511	2735	0.100	2719	0.054
2.04	118	468	491	2900	0.097	2656	0.052

Brinell Hardness.—With 10-millimeter ball, 3,000 kilograms pressure for ½ minute. First hardness on section of sample from the single plates, five wheels; second, hardness of surface of the tread after the wheel was annealed, average of two wheels; third, hardness on the chilled surface of chill test ingot, average of five tests. All tests of three impressions each.

Transverse Strength.—Gray iron, 1¼-inch round bars cast in dry sand mold, broken with 12 inches between supports and strength per square inch determined from the area, deflection in inches, average of eight bars. Chilled iron, 1⅛ inches square bars cast against a chiller, average of eight bars.

FIG. 1A—SURFACE OF CHILLED TREAD, REGULAR MIXTURE
Unetched—Magnified 150 Diameters

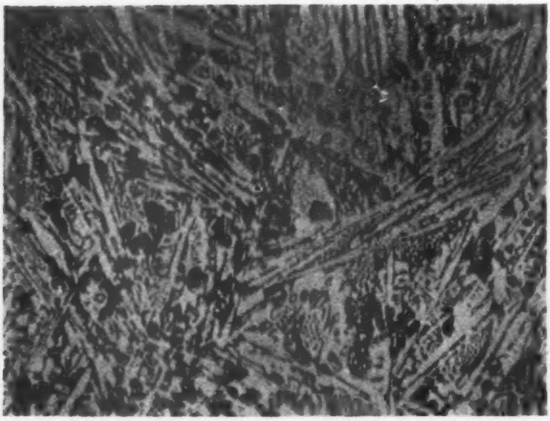


FIG. 1B—SURFACE OF CHILLED TREAD, REGULAR MIXTURE
Etched with Picric Acid—Magnified 150 Diameters

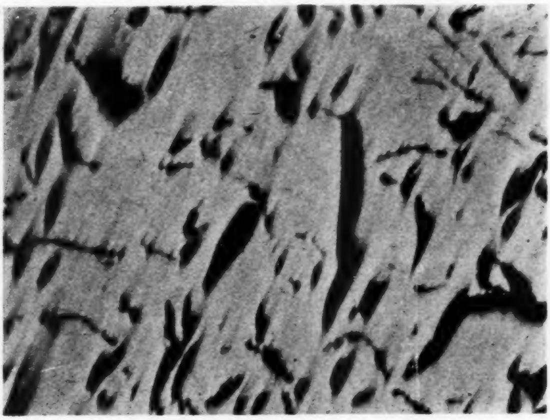


FIG. 1C—WHEEL NO. 10,117, REGULAR MIXTURE
Unetched—Magnified 100 Diameters

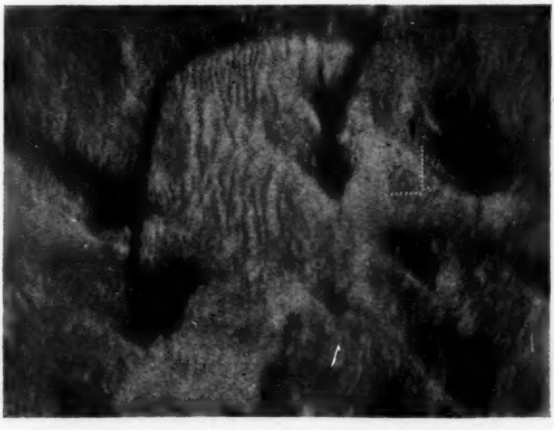


FIG. 1D—WHEEL NO. 10,117, REGULAR MIXTURE
Etched with Picric Acid—Magnified 250 Diameters

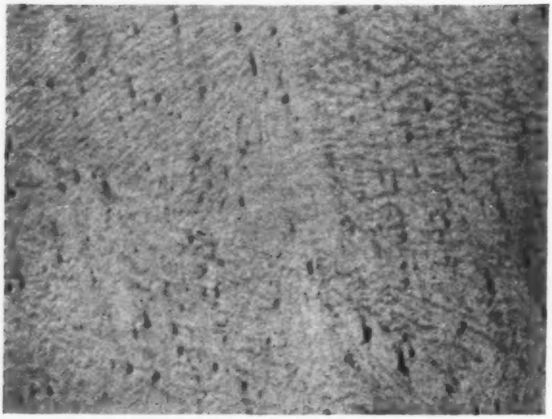


FIG. 1E—CHILL BAR, UNANNEALED, REGULAR MIXTURE
Unetched—Magnified 150 Diameters

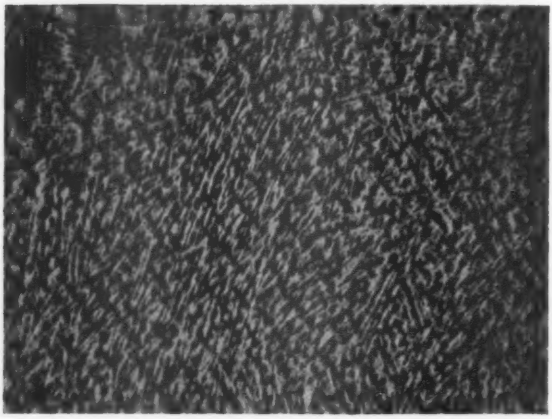


FIG. 1F—CHILL BAR, UNANNEALED, REGULAR MIXTURE
Etched with Picric Acid—Magnified 150 Diameters

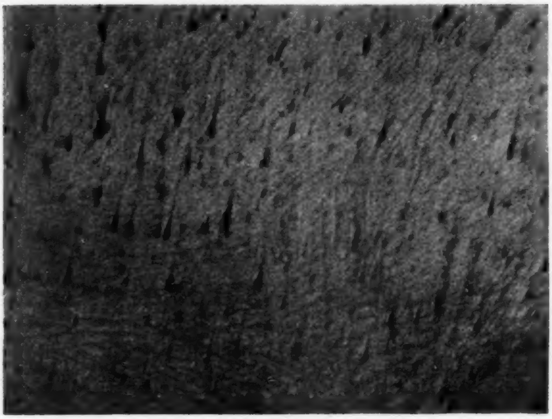


FIG. 2A—SURFACE OF CHILLED TREAD, REGULAR MIXTURE EXCEPT COKE IRON REPLACED WITH CHARCOAL IRON

Unetched—Magnified 150 Diameters

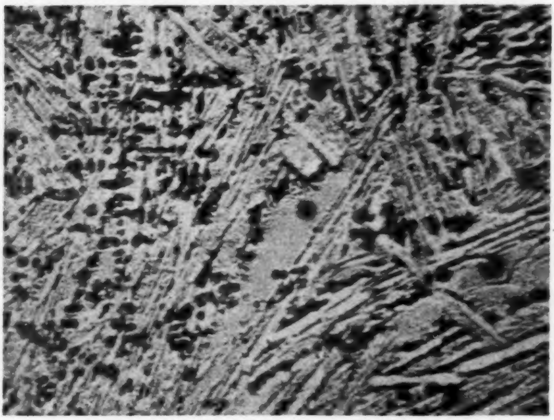


FIG. 2B—SURFACE OF CHILLED TREAD, REGULAR MIXTURE EXCEPT COKE IRON REPLACED WITH CHARCOAL IRON

Etched with Picric Acid—Magnified 150 Diameters

FIG. 2C—WHEEL NO. 13,232, REGULAR MIXTURE EXCEPT COKE IRON REPLACED WITH CHARCOAL IRON

Unetched—Magnified 100 Diameters

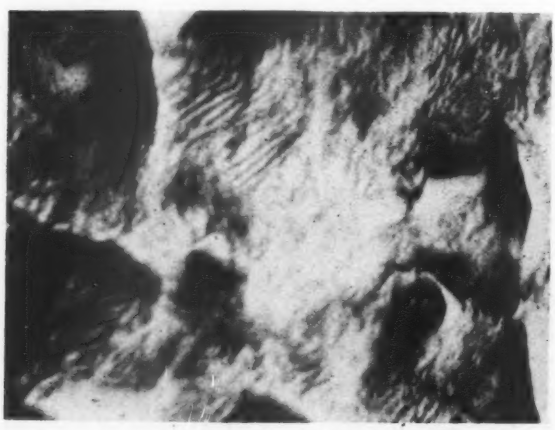


FIG. 2D—WHEEL NO. 13,232, REGULAR MIXTURE EXCEPT COKE IRON REPLACED WITH CHARCOAL IRON

Etched with Picric Acid—Magnified 250 Diameters

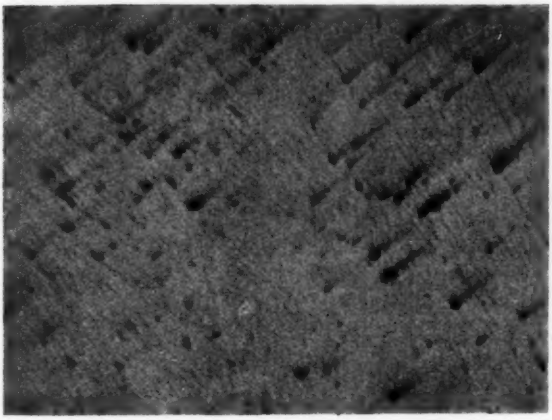


FIG. 2E—CHILL BAR UNANNEALED REGULAR MIXTURE EXCEPT COKE IRON REPLACED WITH CHARCOAL IRON

Unetched—Magnified 150 Diameters

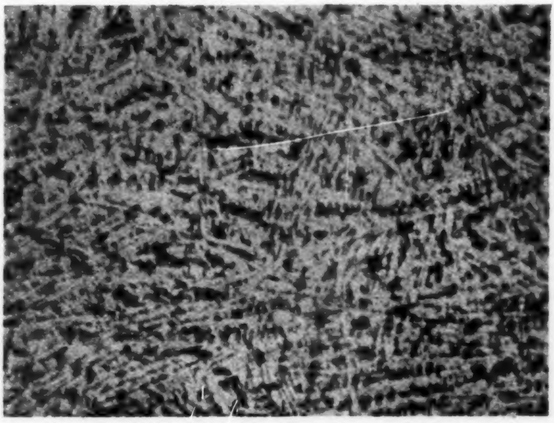


FIG. 2F—CHILL BAR, UNANNEALED REGULAR MIXTURE EXCEPT COKE IRON REPLACED WITH CHARCOAL IRON

Etched with Picric Acid—Magnified 150 Diameters

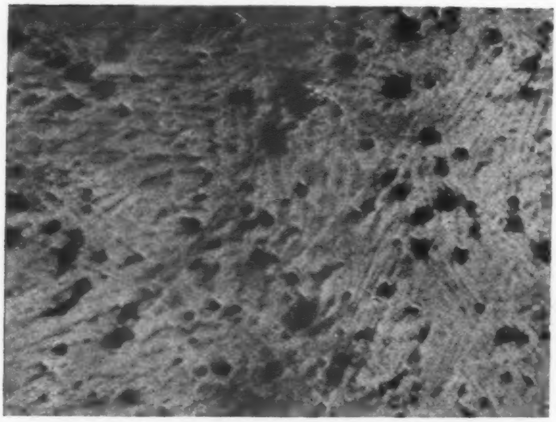


FIG. 3A—SURFACE OF CHILLED TREAD, REGULAR MIXTURE EXCEPT ONE-HALF COKE IRON REPLACED WITH CHARCOAL IRON

Unetched—Magnified 150 Diameters

FIG. 3B—SURFACE OF CHILLED TREAD, REGULAR MIXTURE EXCEPT ONE-HALF COKE IRON REPLACED WITH CHARCOAL IRON

Etched with Picric Acid—Magnified 150 Diameters

FIG. 3C—WHEEL NO. 15,135, REGULAR MIXTURE EXCEPT ONE-HALF COKE IRON REPLACED WITH CHARCOAL IRON

Unetched—Magnified 100 Diameters

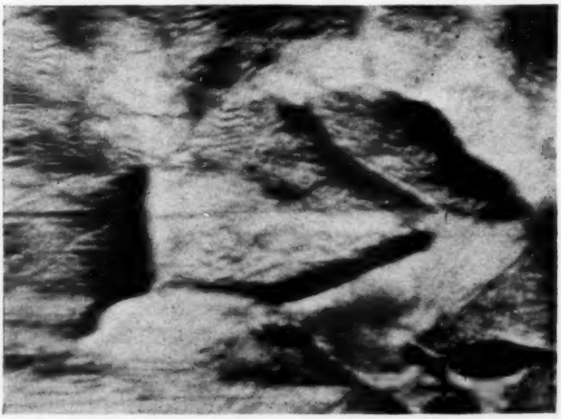


FIG. 3D—WHEEL NO. 15,135, REGULAR MIXTURE EXCEPT ONE-HALF COKE IRON REPLACED WITH CHARCOAL IRON

Etched with Picric Acid—Magnified 250 Diameters

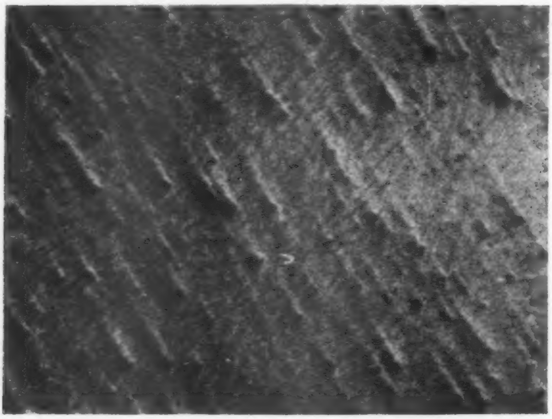


FIG. 3E — CHILL BAR, UNANNEALED REGULAR MIXTURE EXCEPT ONE-HALF COKE IRON REPLACED WITH CHARCOAL IRON

Unetched—Magnified 150 Diameters

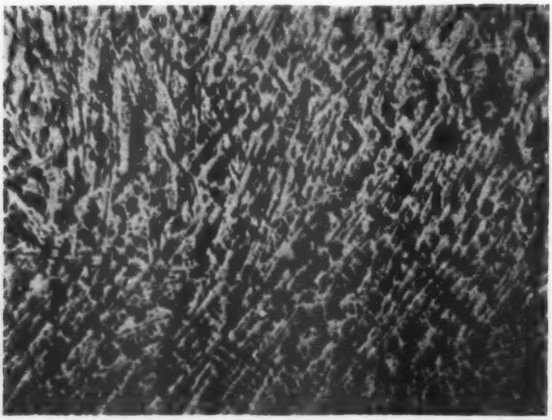


FIG. 3F—CHILL BAR, UNANNEALED REGULAR MIXTURE EXCEPT ONE-HALF COKE IRON REPLACED WITH CHARCOAL IRON

Etched with Picric Acid—Magnified 150 Diameters

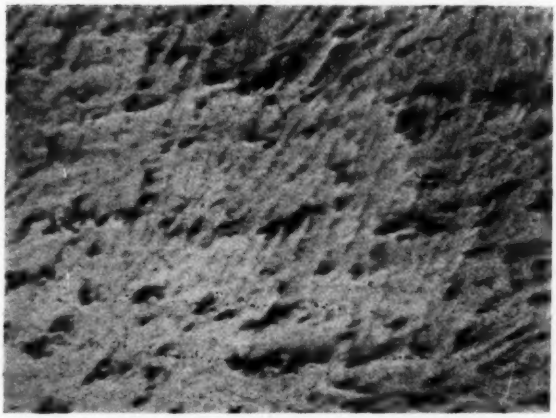


FIG. 4A—SURFACE OF CHILLED TREAD, REGULAR MIXTURE, USING ALL LENOIR SCRAP WHEELS, COKE IRON

Unetched—Magnified 150 Diameters

FIG. 4B—SURFACE OF CHILLED TREAD, REGULAR MIXTURE, USING ALL LENOIR SCRAP WHEELS, COKE IRON

Etched with Picric Acid—Magnified 150 Diameters

FIG. 4C—WHEEL NO. 12,402, REGULAR MIXTURE, USING ALL LENOIR SCRAP WHEELS, COKE IRON

Unetched—Magnified 100 Diameters

FIG. 4D—WHEEL NO. 12,402, REGULAR MIXTURE, USING ALL LENOIR SCRAP WHEELS, COKE IRON

Etched with Picric Acid—Magnified 250 Diameters

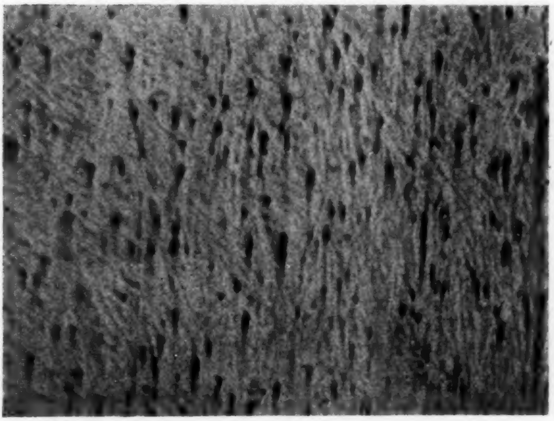


FIG. 4E—CHILL BAR, UNANNEALED, REGULAR MIXTURE, USING ALL LENOIR SCRAP WHEELS, COKE IRON

Unetched—Magnified 150 Diameters

FIG. 4F—CHILL BAR, UNANNEALED, REGULAR MIXTURE USING ALL LENOIR SCRAP WHEELS, COKE IRON

Etched with Picric Acid—Magnified 150 Diameters

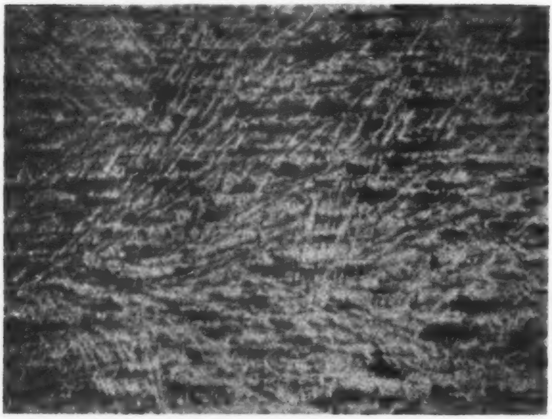


FIG. 5A—SURFACE OF CHILLED TREAD, REGULAR MIXTURE USING ALL LENOIR SCRAP WHEELS, EXCEPT COKE IRON REPLACED WITH CHARCOAL IRON

Unetched—Magnified 150 Diameters

FIG. 5B—SURFACE OF CHILLED TREAD, REGULAR MIXTURE USING ALL LENOIR SCRAP WHEELS, EXCEPT COKE IRON REPLACED WITH CHARCOAL IRON

Etched with Picric Acid—Magnified 150 Diameters

FIG. 5C—WHEEL NO. 15,439, REGULAR MIXTURE USING ALL LENOIR SCRAP WHEELS, EXCEPT COKE IRON REPLACED WITH CHARCOAL IRON

Unetched—Magnified 100 Diameters

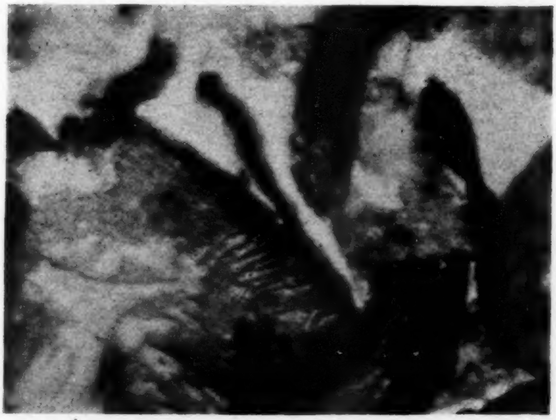


FIG. 5D—WHEEL NO. 15,439, REGULAR MIXTURE USING ALL LENOIR SCRAP WHEELS, EXCEPT COKE IRON REPLACED WITH CHARCOAL IRON

Etched with Picric Acid—Magnified 250 Diameters

FIG. 5E—CHILL BAR, UNANNEALED, REGULAR MIXTURE USING ALL LENOIR SCRAP WHEELS, EXCEPT COKE IRON REPLACED WITH CHARCOAL IRON

Unetched—Magnified 150 Diameters

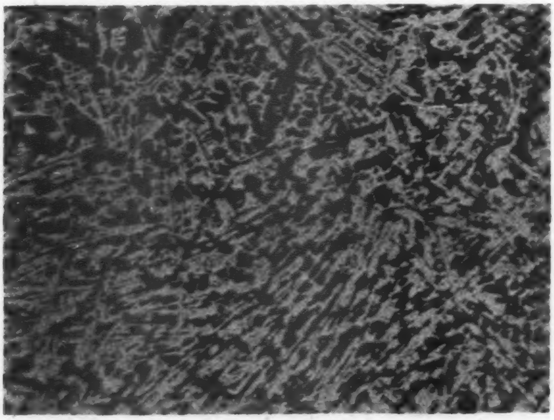


FIG. 5F—CHILL BAR, UNANNEALED, REGULAR MIXTURE USING ALL LENOIR SCRAP WHEELS, EXCEPT COKE IRON REPLACED WITH CHARCOAL IRON

Etched with Picric Acid—Magnified 150 Diameters

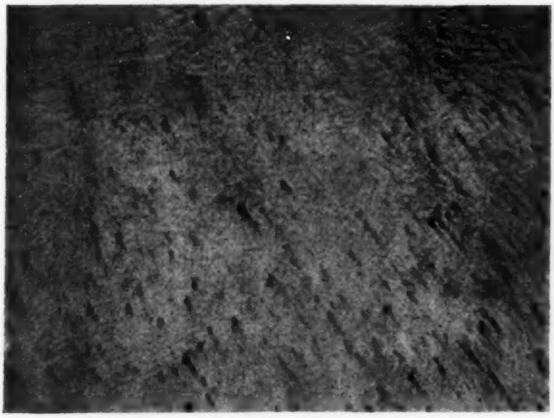


FIG. 6A—SURFACE OF CHILLED TREAD, 20 PER CENT COKE IRON IN MIXTURE

Unetched—Magnified 150 Diameters

FIG. 6B—SURFACE OF CHILLED TREAD, 20 PER CENT COKE IRON IN MIXTURE

Etched with Picric Acid—Magnified 150 Diameters

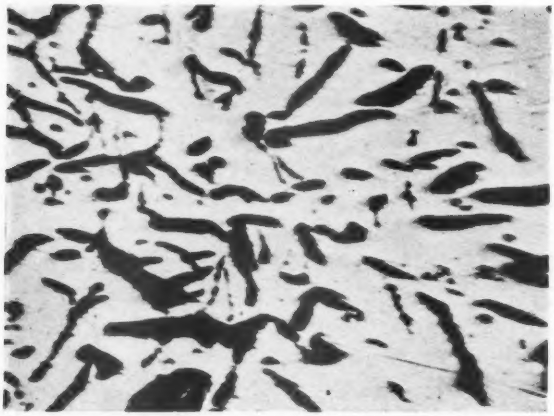


FIG. 6C—WHEEL NO. 15,958, 20 PER CENT COKE IRON IN MIXTURE
Unetched—Magnified 100 Diameters

FIG. 6D—WHEEL NO. 15,958, 20 PER CENT COKE IRON IN MIXTURE
Etched with Picric Acid—Magnified 250 Diameters

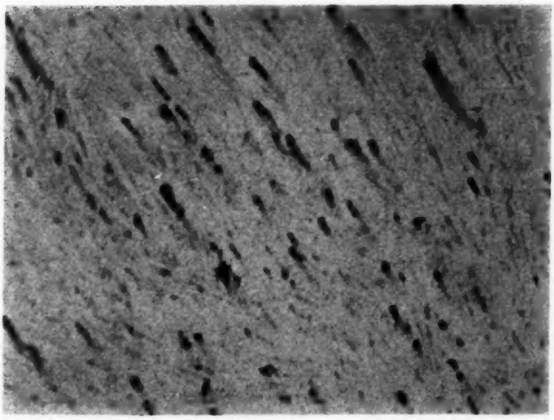


FIG. 6E—CHILL BAR, UNANNEALED, 20 PER CENT COKE IRON IN MIXTURE

Unetched—Magnified 150 Diameters

FIG. 6F—CHILL BAR, UNANNEALED, 20 PER CENT COKE IRON IN MIXTURE

Etched with Picric Acid—Magnified 150 Diameters

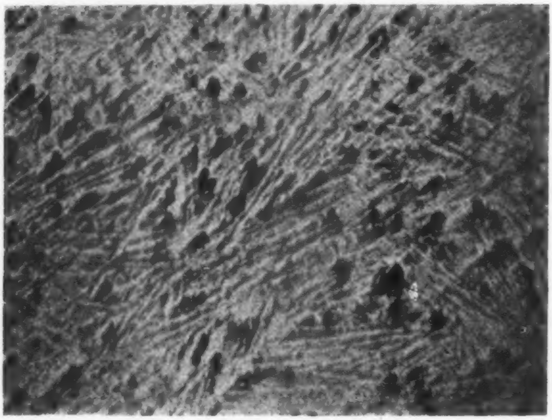


FIG. 7A—SURFACE OF CHILLED TREAD, 30 PER CENT COKE IRON IN MIXTURE

Unetched—Magnified 150 Diameters

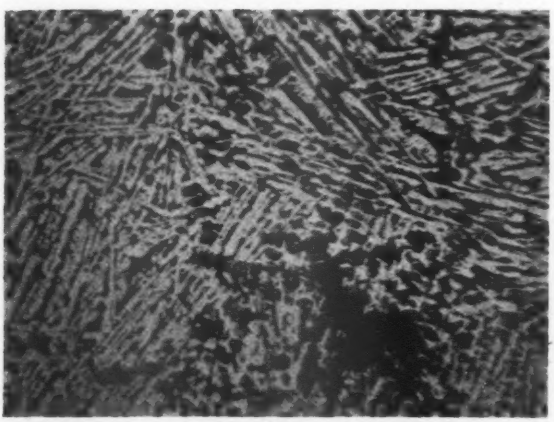


FIG. 7B—SURFACE OF CHILLED TREAD, 30 PER CENT COKE IRON IN MIXTURE

Etched with Picric Acid—Magnified 150 Diameters

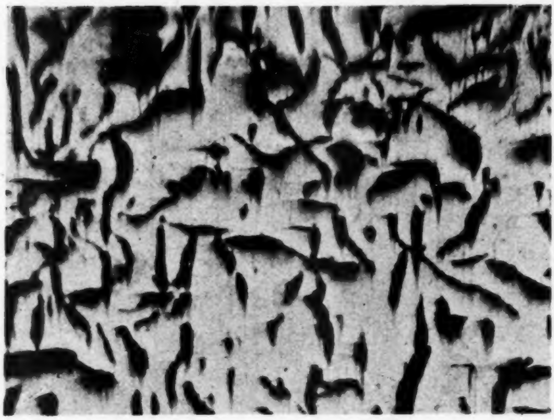


FIG 7C—WHEEL NO. 16,470, 30 PER CENT COKE IRON IN MIXTURE
Unetched—Magnified 100 Diameters

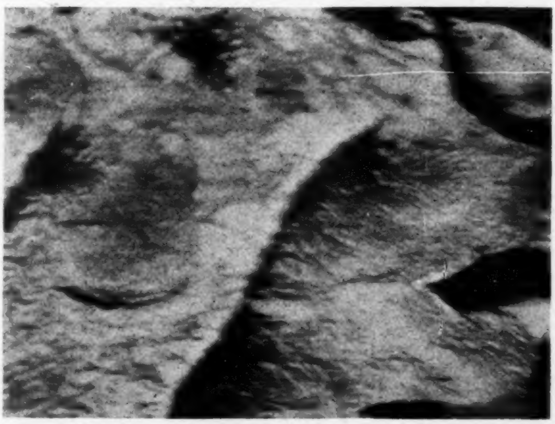


FIG. 7D—WHEEL NO. 16,470, 30 PER CENT COKE IRON IN MIXTURE
Etched with Picric Acid—Magnified 250 Diameters

FIG. 7E—CHILL BAR, UNANNEALED, 30 PER CENT COKE IRON IN MIXTURE

Unetched—Magnified 150 Diameters

FIG. 7F—CHILL BAR, UNANNEALED, 30 PER CENT COKE IRON IN MIXTURE

Etched with Picric Acid—Magnified 150 Diameters

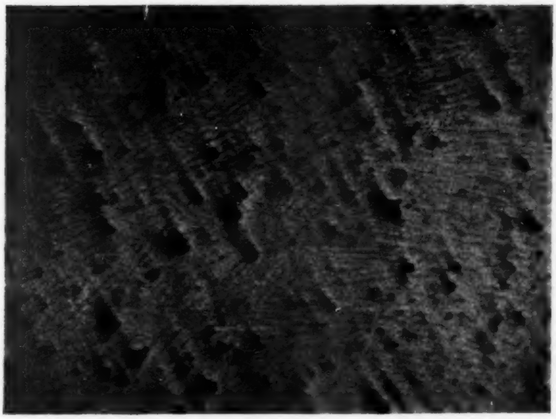


FIG. 8A—SURFACE OF CHILLED THREAD, 20 PER CENT CHARCOAL IRON IN MIXTURE

Unetched—Magnified 150 Diameters

FIG. 8B—SURFACE OF CHILLED TREAD, 20 PER CENT CHARCOAL IRON IN MIXTURE

Etched with Picric Acid—Magnified 150 Diameters

FIG. 8C—WHEEL NO. 13,472, 20 PER CENT CHARCOAL IRON IN MIXTURE

Unetched—Magnified 100 Diameters

FIG. 8D—WHEEL NO, 13,472, 20 PER CENT CHARCOAL IRON IN MIXTURE

Etched with Picric Acid—Magnified 250 Diameters

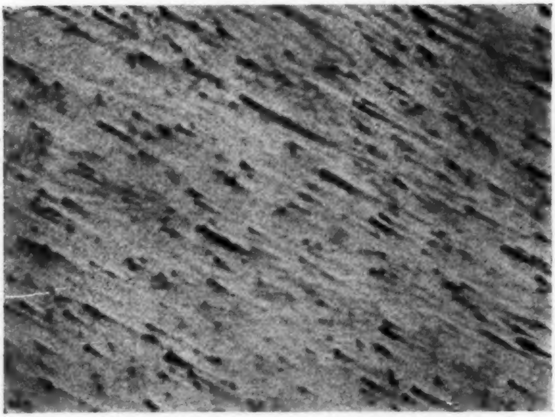


FIG. 8E—CHILL BAR, UNANNEALED, 20 PER CENT CHARCOAL IRON IN MIXTURE

Unetched—Magnified 150 Diameters

FIG. 8F—CHILL BAR, UNANNEALED, 20 PER CENT CHARCOAL IRON IN MIXTURE

Etched with Picric Acid—Magnified 150 Diameters

FIG. 9A—SURFACE OF CHILLED TREAD, 30 PER CENT CHARCOAL IRON IN MIXTURE

Unetched—Magnified 150 Diameters

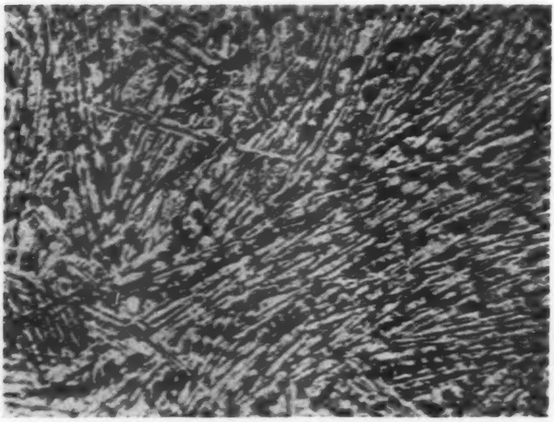


FIG. 9B—SURFACE OF CHILLED TREAD, 30 PER CENT CHARCOAL IRON IN MIXTURE

Etched with Picric Acid—Magnified 150 Diameters

FIG. 9C—WHEEL NO. 14,423, 30 PER CENT CHARCOAL IRON IN MIXTURE

Unetched—Magnified 100 Diameters

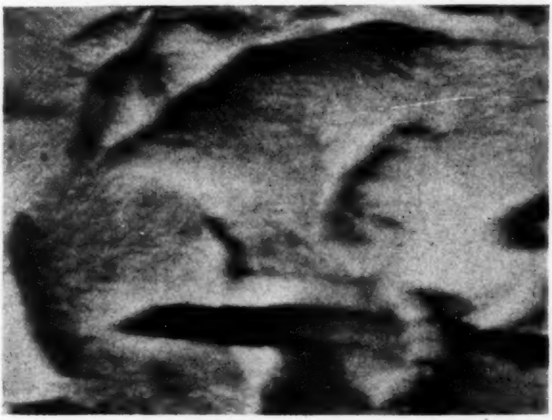


FIG. 9D—WHEEL NO. 14,423, 30 PER CENT CHARCOAL IRON IN MIXTURE

Etched with Picric Acid—Magnified 250 Diameters

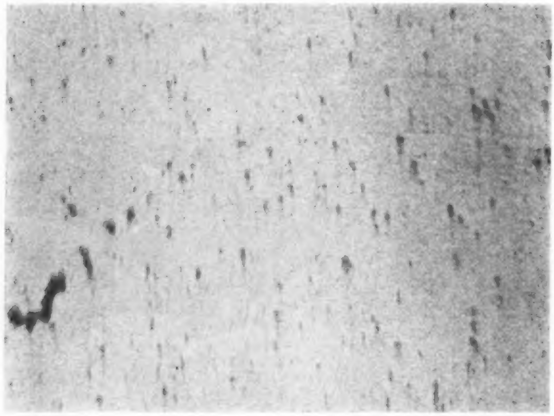


FIG. 9E—CHILL BAR, UNANNEALED, 30 PER CENT CHARCOAL IRON IN MIXTURE

Unetched—Magnified 150 Diameters

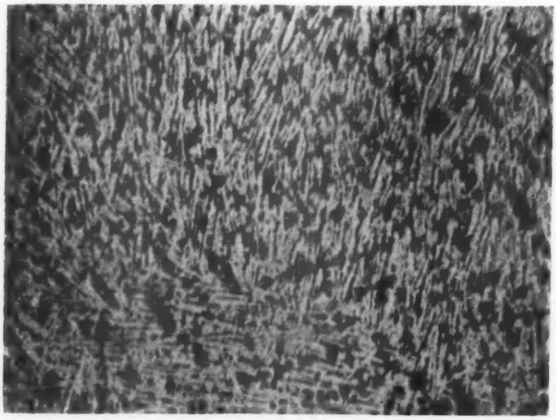


FIG. 9F—CHILL BAR, UNANNEALED, 30 PER CENT CHARCOAL IRON IN MIXTURE

Etched with Picric Acid—Magnified 150 Diameters

Discussion—The Effects of Different Mixtures on the Strength of Chilled Car Wheels

THE CHAIRMAN, B. D. FULLER.—Those of you who are engaged in car wheel work have an interesting subject opened up for discussion as to the effect of different proportions of coke and charcoal iron.

MR. C. C. KAWIN.—I would like to know how high the highest sulphur was in the car wheel mixtures in the tests.

MR. G. S. EVANS.—Our sulphur never exceeds 0.15 to 0.16 per cent.

MR. KELLY.—I would like to ask if you made the test for hardness or any test for wearing qualities of the wheels.

MR. G. S. EVANS.—Unfortunately we are a subsidiary company and the railroad for which wheels were made did not make service tests. We made Brinell hardness tests of both the chill and gray iron portion of all the wheels tested. Not very much difference was shown by the Brinell test in the hardness between 60 per cent steel wheel and an ordinary cast chilled wheel.

THE CHAIRMAN.—Mr. Evans makes a statement that the substitution of charcoal pig iron for coke pig iron does not result in any clearly defined beneficial effects in the strength of the wheels as shown by various tests. It seems to me that that is a question which is debatable.

MR. C. C. KAWIN.—I notice one of the analyses shows phosphorus 0.53 per cent. Is that correct?

MR. G. S. EVANS.—Yes.

MR. C. C. KAWIN.—Is not that unusually high for such a mixture?

MR. G. S. EVANS.—You will understand that that is not our standard mixture, but we use southern coke iron in the tests which carries phosphorus of about 0.85 per cent. That is the reason the phosphorus content is so high in wheels made from the mixtures carrying large percentages of coke pig.

MR. C. C. KAWIN.—I notice the mixture conforms to the standard specifications outside of the phosphorus.

Mr. G. S. Evans.—We tried to hold them within standard specifications as far as we could.

Mr. M. E. Dolan.—I would like to ask the gentleman if there is any difference between the interlacing of the chill and gray iron, when using coke and using charcoal pig iron?

Mr. G. S. Evans.—Our experience seems to indicate that interlacing of the chill is largely the result of the cupola practice. With certain cupola practice, certain melting, and certain analyses, it is possible to produce a very sharp line of demarcation between the chill and the gray iron with either charcoal or coke pig. I cannot say that there is any difference between the two. You can produce about the same with both mixtures.

Mr. C. C. Kawin.—Do I understand that question to be a question as to whether there is a cut-off chill? In my opinion there is no difference at all between the use of the two. With the use of high silicon you get a very high line of demarcation, but I found no difference whatever between the gray iron and the charcoal iron.

Mr. G. S. Evans.—That has been our experience.

The Chairman.—I would like to ask Mr. Evans if in these tests he used the same coke all through or did he experiment with different cokes?

Mr. G. S. Evans.—As far as possible we tried to maintain absolute uniformity of practice for this series of tests. The other preliminary series of tests lasted over a period of two years. In this series from which this paper is compiled we used the same grade of coke all the way through and a very good grade of coke.

The Chairman.—My reason for asking that question is that I have found in conducting experiments in gray iron that the quality of the coke makes a marked difference in the results. In semi-steel experiments, and in experiments which we have conducted to ascertain electrolytic properties, we secured quite a marked difference in the results from using varying grades of coke.

Mr Kelly.—I would like to ask Mr. Evans if he uses more than one cupola, that is, one for car wheels and another for gray castings, or whether he uses only one cupola.

Mr. G. S. Evans.—I did not understand the question.

Mr. Kelly.—Do you use a separate cupola for your car wheel mixture? You make gray castings too?

Mr. G. S. Evans.—Yes.

Mr. Kelly.—Do you use two cupolas or only one?

Mr. G. S. Evans.—We use two cupolas in the gray iron and one in the wheel shop.

Mr. Wilson.—In reaching your conclusions as to the merits of the wheels made with coke iron or charcoal, do you follow the same practice as to the amount of steel or ferro-manganese used in the mixtures?

Mr. G. S. Evans.—We use ferro-manganese merely to bring the manganese content to the desired point, depending on the analyses of the pig we are using. We do that in all cases. If there is any difference in the pig iron or in the scrap, it is necessary to use the manganese to bring it up to a certain point. We endeavor to keep our manganese for our standard wheels around 0.60 per cent.

Mr. Wilson.—What I want to get at is the amount. Do you use the same amount of ferro-manganese in your ladle or in your cupola as in the analysis?

Mr. G. S. Evans.—As I have stated, we use the manganese to bring up the manganese to a certain content in the finished product. This percentage would vary with the different mixtures. In these different mixtures, referred to in this paper, we used in some cases very low manganese where we had a high manganese pig iron, charcoal pig iron, or coke pig iron, so that it varied, to produce the correct analyses in the finished product.

The Chairman.—Does not your question mean the method of using the manganese?

Mr. Wilson.—No; Mr. Evans replied that he varied the amount that he added to his ladle or his cupola according to the manganese content in his pig iron. Is that correct?

Mr. G. S. Evans.—Yes.

Mr J. T. Kent.—It would be interesting to know whether the manganese was added in the ladle or in the cupola. I infer from the gentleman's question that he wanted to know whether manganese was added in the ladle or in the cupola.

Mr. G. S. Evans.—In making the mixture it was added in the cupola.

Report of A. F. A. Committee on Standard Methods for Analyzing Coke

Last year this committee reported the different questions which came up in working out standard methods for analyzing coke, in conjunction with similar committees of the American Chemical Society and the American Society for Testing Materials. Such methods have now been worked out and agreed upon by the three committees. The committee from the American Society for Testing Materials reported this method at the June meeting of that society, and it was adopted without dissent as a tentative method. It will probably be adopted as a standard method after it has been published as a tentative specification for the required length of time.

This society in 1912 adopted methods for coke analysis which will be superseded if the methods now recommended are adopted. The committee feels, however, that a peroxide method for the determination of sulphur should be given as an alternative method to the one offered and recommends that the method formerly adopted be given as an alternative method.

H. E. Diller, Chairman.
Paul Debevoise
A. S. Hummell
R. S. McPherran
Richard Moldenke
J. B. Stoddard

Standard Methods for Laboratory Sampling and Analysis of Coke

DETERMINATION OF TOTAL MOISTURE AND PREPARATION OF LABORATORY SAMPLES.

Apparatus

Galvanized-Iron Pans 24 by 24 by 4 in. Deep.—For total moisture determination.

Balance or Solution Scale.—For weighing the galvanized-iron pans with samples. It should have a capacity of 10 kg. and be sensitive to 1 g.

Jaw Crusher.—For crushing coarse samples to pass a 4-mesh sieve.

Roll Crusher.—For reducing the 4-mesh product to 10-mesh.

Abbe Ball Mill or Hard-Steel Diamond Mortar. — For reducing the 10-mesh product to 60-mesh. The porcelain jars for the ball mill should be approximately 9 in. in diameter and 10 in. high. The flint pebbles should be smooth, hard and well rounded.

A Large Riffle Sampler, with ⅝ or ¾-in. Divisions.—For reducing the 4-mesh sample to 5 lb. (Fig. 1).

A Small Riffle Sampler, with ¼ or ⅜-in. Divisions.—For dividing down the 10 and 60-mesh material to a laboratory sample.

An 8-in. 60-mesh Sieve with Cover and Receiver.

Containers for Shipment to Laboratory.—Samples in which the moisture content is important should always be shipped in moisture-tight containers. A galvanized-iron or tin can with air-tight friction top or a screw top which is sealed with a

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These standard methods for laboratory sampling and analysis of coke were adopted as tentative specifications, subject to a practical trying out and criticisms of these tentative methods are solicited and should be directed to H. E. Diller, chairman, General Electric Co., Erie, Pa.

rubber gasket and adhesive tape is best adapted to this purpose. Glass fruit jars sealed with rubber gaskets may be used, but require very careful packing to avoid breakage in transit. Samples in which the moisture content is of no importance need no special protection from loss of moisture.

Oven, Stove or Hot Plate.—For drying coke samples in the determination of total moisture. If an oven is used it should have openings provided for natural ventilation and should be

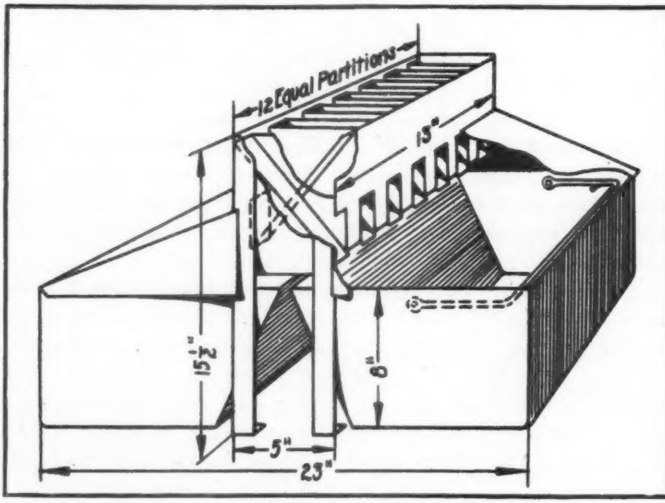

FIG. 1—RIFFLE SAMPLER

capable of being regulated between 104 and 200° C. If the coke is dried on a stove or hot plate a thermometer should be placed in it, and care exercised that the temperature does not exceed 200° C, at any point in the pan of coke.

METHOD.

Total Moisture Determination.—Dry the entire sample received at the laboratory without any preliminary crushing to constant weight at a temperature of not less than 104 nor more than 200° C.[1]

[1]Experiments made at the Bureau of Mines have shown that results checking within 0.5 per cent are obtained between these temperature limits.

Calculate the loss in weight to percentage of moisture, which shall constitute the total moisture in the coke as received at the laboratory.

The allowable difference in duplicate determinations by the same analysis is 0.5 per cent.

Reduction of Sample.—Crush the dried sample mechanically with a jaw or roll crusher, or by hand on a chilled iron or hard-steel plate by impact of a hard bar or sledge, avoiding all rubbing action, as otherwise the ash content will be materially increased by the addition of iron from the sampling apparatus, even though hardened iron or steel is used. Continue the crushing until all the sample passes through a 4-mesh screen, mix and quarter this to not less than 5 lb.; again crush the 5-lb. sample to a fineness of 10-mesh; mix and quarter to 400 g. Transfer this 400-g. portion to the porcelain jar of an Abbe ball mill and pulverize to 60-mesh. When pulverization is complete, pour the contents of the jar on a ½-in. screen and separate the sample from the pebbles by shaking the screen. Reduce the quantity of sample by quartering or riffling to about 50 g. Pass the entire 50-g. portion through a 60-mesh sieve, pulverizing any coarse particles in a diamond mortar, and mix with remainder of sample, preserving the sample for analysis in a rubber-stoppered glass bottle.

In case a ball mill is not available for fine grinding, quarter the 5-lb. 10-mesh sample to 200 g. and pulverize to 60-mesh, by impact in a hard-steel diamond mortar. The use of rubbing surfaces such as a disk pulverizer or a bucking board is never permissible for grinding coke.

NOTES.

The accuracy of the method of preparing laboratory samples should be checked frequently by resampling the rejected portions and preparing a duplicate sample. The ash in the two samples should not differ more than 0.4 per cent.

DETERMINATION OF MOISTURE ON 60-MESH SAMPLE

APPARATUS.

Moisture Oven.—An ordinary drying oven with openings for natural air circulation and capable of temperature regulation between limits of 104 and 110° C. may be used.

Capsules with Covers.—A convenient form, which allows the ash determination to be made on the same sample, is the Royal Meissen porcelain capsule No. 2, 7/8 in. deep and 1 3/4 in. in diameter. This is to be used with a well-fitting flat aluminum cover, illustrated in Fig. 2.

Platinum crucibles or glass capsules with ground-glass caps may also be used. They should be as shallow as possible, consistent with convenient handling.

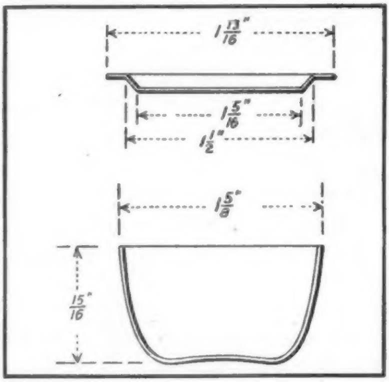

FIG. 2—PORCELAIN CAPSULE WITH FLAT ALUMINUM COVER

Method.

Heat the empty capsules under the conditions at which the coke is to be dried, stopper or cover, cool over concentrated sulphuric acid, sp. gr. 1.84, for 30 minutes, and weigh. Transfer to the capsule an amount slightly in excess of 1 g. and bring to exactly 1 g. in weight (± 0.5 mg.) by quickly removing the excess weight of coke with a spatula.

Place the capsules, uncovered, in a pre-heated oven (at 104 to 110° C.). Close the oven at once and heat for 1 hour. Then open the oven, cover the capsules quickly and place them in a desiccator over concentrated sulphuric acid. When cool, weigh.

The percentage moisture in the 60-mesh sample shall be used to calculate the other results to a dry basis.

The allowable differences in duplicate determinations are as follows:

	Per cent.
Same analyst	0.2
Different analysts	0.3

DETERMINATION OF ASH.

APPARATUS

Gas or Electric Muffle Furnace or Meker Burner.—The muffle should have good air circulation and be capable of having its temperature regulated to not exceed 950° C.

Porcelain Capsules.—Royal Meissen Porcelain Capsules No. 2, ⅞ in. deep and 1¾ in. in diameter, or similar shallow dishes or platinum crucibles.

METHOD.

Place the capsules containing the dried coke from the moisture determination in a muffle furnace or over a burner, and heat to redness at such a rate as to avoid mechanical loss. Finish the ignition to constant weight ($\pm$ 0.001 g.) at a temperature not exceeding 950° C. Cool in a desiccator and weigh.

The allowable differences in duplicate determinations are as follows:

	Per cent.
Same analyst	0.2
Different analysts	0.3

NOTES.

Before replacing the capsules in the muffle for ignition to constant weight, the ash should be stirred with a platinum or nichrome wire. Stirring once or twice before the first weighing hastens complete ignition.

Test the ash for unburned carbon, by moistening it with alcohol; any carbon remaining will show as black particles.

DETERMINATION OF VOLATILE MATTER.

Apparatus.

Platinum Crucible with Tightly Fitting Cover.—The crucible should be of 10-cc. capacity, with capsule cover having thin flexible sides fitting down into crucible. Or the double-crucible method may be used, in which the sample is placed in a 10 or 20-cc. platinum crucible, which is then covered with another crucible of such a size that it will fit closely to the sides of the outer crucible, and its bottom will rest 1/3 to 1/2 in. above the bottom of the outer crucible.

Vertical Electric Tube Furnace; or a Gas or Electrically Heated Muffle Furnace.—The furnace may be of the form shown in Fig. 3. It is to be regulated to maintain a temperature of 950° C. (±20° C.) in the crucible, as shown by a thermocouple kept in the furnace. A Meker burner may be used, if satisfactory to both parties to the contract.

Method.

Weigh 1 g. of the coke in a weighed 10-cc. platinum crucible, close with capsule cover and place on platinum or nichrome-wire supports in the furnace chamber, which must be at a temperature of 950° C. (±20° C.). After the crucible has been heated 2 or 3 minutes tap the cover lightly to more perfectly seal the crucible and thus guard against the admission of air. After heating exactly 7 minutes, remove the crucible from the furnace and, without disturbing the cover, allow it to cool in a desiccator. Weigh as soon as cold. The loss of weight minus moisture equals the volatile matter.

The allowable differences in duplicate determinations are as follows:

	Per cent.
Same analyst	0.2
Different analysts	0.4

Alternative Method, Using Meker Burner

Weigh 1 g. of the coke in a weighed 10 or 20-cc. platinum crucible, close with capsule cover or another crucible as described above under "apparatus", and place in the flame of a

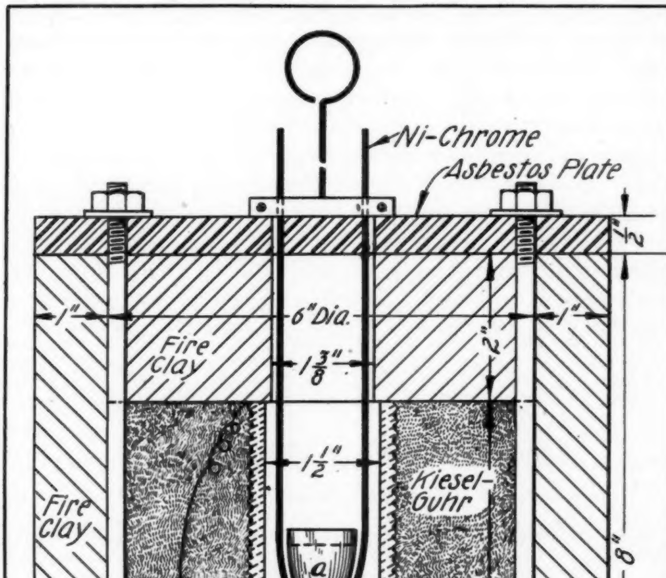

FIG. 3—ELECTRIC TUBE FURNACE FOR DETERMINING VOLATILE MATTER. FOR 110-VOLT ALTERNATING CURRENT, 60 FT. OF NICHROME WIRE, NO. 17 B. & S. GAGE WILL GIVE THE REQUIRED TEMPERATURE. THE TEMPERATURE MUST BE CONTROLLED BY AN EXTERNAL RESISTANCE

No. 4 Meker burner, having approximately an outside diameter at the top of 25 mm. and giving a flame not less than 15 cm. high. The temperature should be 950° C. (± 20° C.), as determined by placing a thermocouple through the perforated cover, which for this purpose may be of nickel or asbestos. The junction of the couple should be placed in contact with the center of the bottom of the crucible; or the temperature may be indicated by the fusion of pure potassium chromate in the covered crucible (fusion of K_2CrO_4, 940° C.). The crucible is placed in the flame about 1 cm. above the top of the burner and the heating is continued 7 minutes. Where the gas pressure is variable it is well to use a U-tube attachment to the burner.

DETERMINATION OF FIXED CARBON.

Compute fixed carbon as follows:

100—(moisture+ash+volatile matter)=fixed carbon (expressed in percentages).

DETERMINATION OF SULPHUR BY THE ESCHKA METHOD.

Apparatus.

Gas or Electric Muffle Furnace, or Burners.—For igniting coke with the Eschka mixture and for igniting the barium sulphate.

Porcelain, Silica, or Platinum Crucibles or Capsules.—For igniting coke with the Eschka mixture.

No. 1 Royal Meissen porcelain capsule, 1 in. deep and 2 in. in diameter. This capsule, because of its shallow form, presents more surface for oxidation and is more convenient to handle than the ordinary form of crucible.

No. 1 Royal Berlin porcelain crucibles, shallow form, and platinum crucibles of similar size may be used. Somewhat more time is required to burn out the coke owing to the deeper form, than with the shallow capsules described above.

No. 0 or 00 porcelain crucibles, or platinum, alundum or silica crucibles of similar size are to be used for igniting the barium sulphate.

Solutions and Reagents.

Barium Chloride.—Dissolve 100 g. of barium chloride in 1,000 cc. of distilled water.

Saturated Bromine Water.—Add an excess of bromine to 1,000 cc. of distilled water.

Eschka Mixture.—Thoroughly mix 2 parts (by weight) of light calcined magnesium oxide and 1 part of anhydrous sodium carbonate. Both materials should be free as possible from sulphur.

Methyl Orange.—Dissolve 0.02 g. in 100 cc. of hot distilled water and filter.

Hydrochloric Acid.—Mix 500 cc. of hydrochloric acid, sp. gr. 1.20, and 500 cc. of distilled water.

Normal Hydrochloric Acid.—Dilute 80 cc. of hydrochloric acid, sp. gr. 1.20, to 1 liter with distilled water.

Sodium Carbonate.—A saturated solution, approximately 60 g. of crystallized or 22 g. of anhydrous sodium carbonate in 100 cc. of distilled water.

Sodium-Hydroxide Solution.—Dissolve 100 g. in 1 liter of distilled water. This solution may be used in place of the sodium-carbonate solution.

Method.

Preparation of Sample and Mixture.—Thoroughly mix on glazed paper, 1 g. of 60-mesh coke and 3 g. of Eschka mixture. Transfer to a No. 1 Royal Meissen porcelain capsule, 1 in. deep and 2 in. in diameter, or a No. 1 Royal Berlin crucible or platinum crucible of similar size, and cover with about 1 g. of Eschka mixture.

Ignition.—On account of the amount of sulphur contained in artificial gas, the crucible shall be heated over an alcohol, gasoline or natural gas flame, as in procedure (*a*) below, or in a gas or electrically heated muffle, as in procedure (*b*) below.

The use of artificial gas for heating the coke and Eschka mixture is permissible only when crucibles are heated in a muffle.

(*a*) Heat the crucible, placed in a slanting position on a triangle, over a low flame at first, then gradually increase the temperature and stir occasionally until all the black particles disappear, which is an indication of the completeness of the procedure.

(*b*) Place the crucible in a warm muffle and gradually raise the temperature to 870-925° C. (cherry-red heat) in about ½ hour. Maintain this maximum temperature until on stirring all black particles have disappeared.

Subsequent Treatment.—Remove and empty the contents into a 200-cc. beaker and digest with 100 cc. of hot water for ½ to ¾ hour, with occasional stirring. Filter and wash the insoluble matter by decantation. After several washings in this manner, transfer the insoluble matter to the filter and wash 5 times, keeping the mixture well agitated. Treat the filtrate, amounting to about 250 cc., with 10 to 20 cc. of saturated bromine water, make slightly acid with hydrochloric acid and boil to expel the liberated bromine. Make just neutral to methyl orange with sodium-hydroxide or sodium-carbonate solution, then add 1 cc. of normal HCl. Boil again and add slowly from a pipette with constant stirring 10 cc. of a 10 per cent solution of barium chloride ($BaCl_2.2H_2O$). Continue boiling for 15 minutes and allow to stand for at least 2 hours, or preferably overnight, at a temperature just below boiling. Filter through an ashless filter paper and wash with hot distilled water until a silver-nitrate solution shows no precipitate with a drop of the filtrate. Place the wet filter containing the precipitate of barium-sulphate in a weighed platinum, porcelain, silica or alundum crucible, allowing a free access of air by folding the paper over the precipitate loosely to prevent spattering. Smoke the paper off gradually and at no time allow it to burn with flame. After the paper is practically consumed raise the temperature to approximately 925° C. and heat to constant weight.

The residue of magnesia, etc., after leaching, should be dissolved in hydrochloric acid and tested with great care for

sulphur. When an appreciable amount is found this should be determined quantitatively. The amount of sulphur retained is by no means a negligible quantity.[1]

Blanks and Corrections.—In all cases a correction must be applied either (1) by running a blank exactly as described above, using the same amounts of all reagents that were employed in the regular determination, or, more surely, (2) by determining a known amount of sulphate added to a solution of the reagents after these have been put through the prescribed series of operations. If this latter procedure is adopted and carried out, say, once a week or whenever a new supply of a reagent must be used, and for a series of solutions covering the range of sulphur content likely to be met with in coke, it is only necessary to add or to subtract from the weight of barium sulphate obtained from a coke whatever deficiency or excess may have been found in the appropriate "check" in order to obtain a result that is more certain to be correct than if a "blank" correction as determined by the former procedure is applied. This is due to the fact that the solubility error for barium sulphate is, for the amounts of sulphur in question and the conditions of precipitation prescribed, probably the largest one to be considered. Barium sulphate is soluble[2] in acids and even in pure water, and the solubility limit is reached almost immediately on contact with the solvent. Hence, in the event of using reagents of very superior quality or of exercising more than ordinary precautions, there may be no apparent "blank," because the solubility limit of the solution for barium sulphate has not been reached, or at any rate not exceeded.

(Weight of $BaSO_4$—blank)$\times$10=percentage of sulphur.

The allowable differences in duplicate determinations are as follows:

	Per cent.
Same analyst	0.03
Different analysts	0.05

[1]*Journal*, Am. Chem. Soc., Vol. 21, p. 1128 (1899).
[2]*Journal*, Am. Chem. Soc. Vol. 32, p. 588 (1910); Vol. 33, p. 829 (1911).

Alternative Method

Apparatus

Crucible.—A soft steel or nickel crucible of about 40 cc. capacity, the lid being perforated with a small hole for the introduction of the igniting wire.

Crucible Stand.—Any arrangement suitable for holding the crucible firmly in place and out of contact with the beaker during the peroxide combustion.

Method.

To the dry crucible add first 12 g. of sodium peroxide and 0.5 g. of powdered potassium chlorate, then exactly 0.7 g. of coke (80 mesh) and mix thoroughly by means of a small spatula. Place the covered crucible on its stand in a 20-ounce beaker containing enough water to immerse the lower half of the crucible.

Ignite the crucible contents by thrusting in, for a moment, a red hot wire through the lid hole. Wait two minutes or longer for the mass to cool somewhat, remove the stand and tip over the crucible on its side in the water. After the fusion dissolves, rinse and remove the crucible.

Acidify the solution with hydrochloric acid, then add ammonia in slight excess, filter and wash. To the filtrate add a drop of methyl orange, then hydrochloric acid from a graduated pipette or burette until 0.5 cc. in excess. Bring to boiling, add drop wise about 10 cc of barium chloride solution, continue boiling at least fifteen minutes longer, and allow it to stand in a warm place for not less than two hours, filter, wash until the silver nitrate test shows no chlorides, ignite and weigh as $BaSO_4$.

Grams $BaSO_4 \times 19.6 =$ per cent sulphur.

DETERMINATION OF PHOSPHORUS

Method No. 1. *To Cover all Cases.*—To the ash from 5 g. of coke in a platinum capsule is added 10 cc. of nitric acid and 3 to 5 cc. of hydrofluoric acid. The liquid is evaporated and

the residue fused with 3 g. of sodium carbonate. If unburned carbon is present 0.2 g. of sodium nitrate is mixed with carbonate. The melt is leached with water and the solution filtered. The residue is ignited, fused with sodium carbonate alone, the melt leached and the solution filtered. The combined filtrates, held in a flask, are just acidified with nitric acid and concentrated to a volume of 100 cc. To the solution, brought to a temperature of 85° C., is added 50 cc. of molybdate solution and the flask is shaken for 10 minutes. The precipitate is washed six times, or until free from acid, with a 2 per cent solution of potassium nitrate, then returned to the flask and titrated with standard sodium-hydroxide solution. The alkali solution may well be made equal to 0.00025 g. of phosphorus per cubic centimeter, or 0.005 per cent, for a 5-g. sample of coke, and is 0.995 of one-fifth normal.[1] Or the phosphorus in the precipitate is determined by reduction and titration of the molybdenum with permanganate.

Method No. 2.—When titanium is so low as to offer no objection, the ash is decomposed as under method No. 1, but evaporation is carried only to a volume of about 5 cc. The solution is diluted with water to 30 cc., boiled and filtered. If the washings are turbid they are passed again through the filter. The residue is ignited in a platinum crucible, fused with a little sodium carbonate, the melt dissolved in nitric acid and its solution, if clear, added to the main one. If not clear it is filtered. The subsequent procedure is as under method No. 1. The fusion of the residue may be dispensed with in routine work on a given coke if it is certain that it is free from phosphorus.

Note on Method No. 1.—The advantage of the use of hydrofluoric acid in the initial attack of the ash lies in the resulting removal of silica. Fusion with alkali carbonate is necessary for the elimination of titanium, which if present and not removed will contaminate the phospho-molybdate and is said to sometimes retard its precipitation.

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[1]Ulmann and Buch, *Chemical Engineer*, Vol. 10, p. 130 (1909).

Use of By-Product Coke in Foundries

By Geo. A. T. Long, Chicago

The requisites of a good by-product foundry coke are first, high carbon; second, low sulphur; third, good cellular structure, and fourth, that the product shall be uniform. The carbon and sulphur are primarily the result of the quality of coal which is used in the ovens for coking purposes. The structure, however, depends on proper preparation of the coal before coking, as well as upon the arrangement of the ovens in which the coal is coked and upon the temperature of the coking chamber. It, therefore, does not follow that all by-product cokes are suitable for foundry use.

In using coke in the cupola, as little wood as possible should be used. Use just sufficient to ignite the coke. The height of the bed above the tuyere depends on the metal being melted. For ordinary soft gray iron castings the bed should be brought up to 24 inches above tuyeres, settled and thoroughly burned through before charging any iron. With low carbon irons such as steel mixtures, a higher bed is required, no less than 30 inches above the tuyeres after settling, as low carbon may require more fuel. The next question is, how much iron shall we use to a charge? I contend the charge that is put on the bed should be used all through the heat, whether the heat be five charges or 50, as the closer we can work to the melting zone the better will be the results obtained. I also believe in making small charges, as this practice gives a more uniform mixture, keeps the iron hotter and saves fuel. In the ordinary cupola 24 to 36 inches inside, I use 1,000-pound charges; in cupolas from 36 to 54 inches I prefer 2,000 pounds. In cupolas larger than this, 3,000-pound charges would be the limit I would carry, using one pound of fuel to 10 pounds of iron between charges, unless using steel mixtures. The larger the percentage of steel, the more fuel is necessary. For instance, with a 25 per cent steel mixture I would use 150 pounds of coke to 1,000 pounds of metal, for I think the

secret of all steel mixtures is in bringing the carbons up in order to get fluid metal.

How Much Air Should be Used?

The next question is, how much air should be used to get proper results? I do not think there is any one thing that varies so much in foundry practice as the air going into the cupola. You will seldom find two foundrymen of the same opinion, or using the same air pressure. The pressure will range all the way from six to 30 ounces. I believe the lower pressure that you melt metal with, the better results you obtain; the oxidation is less, the sulphur is lower, and the metal is softer and truer to mixture. High blast pressure tends to combine the carbon and reduces silicon and manganese, causing hard iron. If the coke does not have a good structure it will not stand up and much the same trouble will result. A number of troubles attributed to coke, such as slag, hard iron, shrinkage, etc., can be all put down to high pressure.

I want to mention in passing, a complaint about sulphur investigated a few months ago. In this case the sulphur jumped up 0.15 or 0.20 per cent in the castings, and immediately the coke was assumed to be the cause, for they said no change had occurred in the irons used. This was true, but upon looking into the matter I found they had discontinued the use of ferro-manganese, owing to its high price, and this reduced their manganese as charged, about 0.40 per cent.

As to slag, when it starts right at the beginning of the heat it usually comes from too low a bed, which allows the air to reach the iron. With this condition slag will show at once. Very often I find the daubing used to line the cupola reducing the slag before the blast is put on; this is due to the nature of the clay used.

Some foundrymen think it is necessary to select large coke for the bed. This is a mistake, for all large size coke permits the passage of air too freely. I find the best results are obtained by straight forking with no attempt to select large pieces for the bed. Large coke leaves too much air space, while a mixture of sizes packs enough to confine the air and keeps the blast from too direct contact with the iron. Trouble with cold iron at the start of a heat is often due to a bed

of large size coke, for with such a bed two or three charges must be melted before the coke settles properly.

I find that a great many foundries over the country are using extra coke every few charges. I think this is an entirely wrong practice. They do this to renew a bed which has been lowered by melting too large charges of iron. As an example, a foundry I visited a short time ago has a cupola 42 inches inside measurement, with 13 inches from the sand bottom to the tuyeres. They were using 4,000 pounds of iron to each charge with 450 pounds of coke between charges. Every seventh charge they used 200 pounds of extra coke. Still their iron was not right and they were troubled with slag. The cause of their trouble was too large a charge of iron and too much coke in a body. The charge of 450 pounds of coke would fill up the cupola considerably above the melting zone, and would have to be burned down to the zone before it would do any work. The large charge of iron would then force the melting zone so low that the air would reach the metal. In charging this cupola, I simply cut out the extra coke and charged 2,000 pounds of iron to 200 pounds of coke, reduced the air from 16 ounces to 10 ounces and they have had no further trouble since this change was made.

A Question of Lining

In continuous melting where a cupola is run from 10 to 18 hours a day, the charging is practically the same. It is not a question of how long you can run a cupola; it is a matter of how long the lining will last. I find the greatest trouble with continuous melting arises from the slag-notch closing up. I have not found anything equal to limestone for fluxing. The trouble with many cupolas built for continuous melting is that the slag-notch is too close to the tuyeres. I think the slag-notch should be at least 10 inches below the bottom of the tuyeres; a slag-notch so placed practically will take care of itself and will not require continual poking.

In using by-product coke manufactured by people who are making a specialty of foundry coke you are sure to get a uniform product both in fixed carbon and sulphur. A uniform fuel is the greatest asset a foundryman can have.

Discussion—Use of By-Product Coke in Foundries

THE CHAIRMAN, B. D. FULLER.—You now have the coke question before you. By-product coke has been mentioned in our talks this morning several times, and if anybody wishes any information or wishes to question Mr. Long, we will be glad to hear from him. From my experience with by-product coke, I have found some of it very good and some of it not so good. In the early days of by-product coke, of course, things were not handled possibly as they are today, and in my experience in using it, covering a number of years, we got some of it that gave us very good results and some of it did not, but I have lately used some with very fine results. Possibly some of you gentlemen who are using it would like to say something about it.

MR. G. E. JONES.—Our company in specifying coke demands fixed carbon at 88 to 90 per cent. We are perfectly safe in doing so and always get it with the ash running about 8 to 9 per cent. I would not advise a coke that was much lower than that, because the coke has not sufficient body, but a coke that runs 8 to 9 is very good coke, with fixed carbon 88 to 90 and with the sulphur as low as you can possibly get it.

MR. C. C. KAWIN.—There is no question but that a certain amount of ash is necessary, but there are one or two cokes on the market that have low ash but which are not good cokes. We make it a point that it is necessary to watch the structure and the size of the pieces, and a coke that runs 8 to 10 per cent of ash is no doubt the standard, but there are two or three cokes on the market that have between 4 and 6 per cent of ash that are exceptionally good.

THE CHAIRMAN.—I know from recent experience with by-product coke, right here in Cleveland, that some very fine results have been obtained as to melting ratio and quality of the product made. As I said before, I believe by-product coke today is much more uniform than it was 10 or 12 years ago when I had my first experience with it.

MR. G. A. T. LONG.—It was then in the experimental stage.

The Introduction of Molding Machines in Foundries

By A. O. Backert, Cleveland.

Never before in the history of the foundry industry has the labor shortage been more acute than at present and never before has the feeling of unrest been more prevalent and the demands for higher wages been more widespread than today. With the demand for his product greatly in excess of his output, it is only natural for the foundryman to turn to the adoption of labor-saving devices to increase his production, but what to do and how to do it, is the problem confronting him.

It is generally conceded that no device can be installed in the foundry that will effect economies commensurate with those obtainable from the molding machine. For more than a quarter of a century this equipment has been on a commercial basis and its growing use has made possible the large tonnage of castings annually produced. In the pioneer days of the introduction of this device it was not unusual for the entire force to walk out in shops where the machine was placed on trial. The principle of the limitation of output was still deeply rooted at that time and the workmen believed that their jobs would be placed in jeopardy if they permitted the molding machine to remain. The all-around molder had a natural antipathy for any mechanical device, believing that his skill, acquired by years of experience, never could be replaced by an inanimate object wrought from iron and steel.

Limitation of Output

Organized labor likewise was opposed to an increase in the daily output per man and this attitude forced the foundryman to resort to the subterfuge of employing apprentices or handymen on machines. When it became apparent to the molders that the machine operators, after they had become skilled, were averaging greater wages than they could earn on the day basis,

their interest in this equipment increased and it was not unusual, nor is it today, for a molder to make a request that he be given an opportunity to try his hand at this new-fangled device. Except in extreme cases, it is doubtful if labor difficulties will be experienced in plants where machines are first introduced and organized labor has recognized this forward step in molding practice by formulating rules that govern their introduction and operation.

The foundryman who has successfully operated molding machines for many years is familiar with their many advantages, but the novice who is driven to the extremity of considering the use of this labor-saving equipment, due to a shortage of labor, still has many misgivings and is doubtful of the results that will follow his venture into this unexplored realm of greater output. The fact that the trail has been blazed frequently offers only minor inducements and that there is a machine for practically every purpose is still viewed with suspicion. To convince this foundryman that he will find fair weather ahead, this paper was undertaken, and an investigation was made of the subject that should prove to him, beyond a doubt, that the molding machine is everything that is claimed for it, and more.

Increase in Output

The increase in output that will follow the introduction of this mechanical method of molding varies from 100 to 500 per cent. Variations in ramming are eliminated, castings are more uniformly of the same weight and when the men work on a piece basis, they invariably earn greater wages than when employed on the floor.

Co-operation

Co-operation, however, is the most important feature essential to the introduction of the molding machine. Without it, every attempt will fail. The interest of the superintendent and the foreman must be obtained to insure the success of the venture, since without it, the workmen will make only a half-hearted attempt to operate the equipment to its capacity. When the co-operation of the shop executives has been secured, and when it becomes generally known among the force that the

machine is to stay, no difficulty will be experienced, provided it is adapted to the line of work for which it is installed.

For the purpose of obtaining expressions of opinion from foundrymen who have been notably successful in the operation of molding machines, a letter of inquiry was circulated to ascertain how they first introduced machines in their shops; whether their machine men are designated as apprentices, operators or molders; on what basis these men are paid; what affect the use of molding machines has had on the output, and whether it is the policy to change the piecework price after it has once been fixed, or whether a reduction is made in the rate when a greater output is made possible by further improvements in practice.

Piecework Basis

A total of 65 replies was received and with only a few exceptions, the men operate on a piecework basis. The day rate has been found impractical, since the output, wherever it is in force, is not greatly increased over that made on the floor or on the bench. Not all of the foundrymen replied to the inquiry with reference to the change of the piecework rate after it once has been established, but of the 41 answers received, 32 stated that they never make a change in the rate, regardless of the output and the wages earned, while the remaining nine replied that the rate is reduced only after it becomes apparent to the men that it is entirely too high and that an adjustment should be made in view of the improvements effected by the firm which makes possible a greatly increased number of molds per day than when the rate originally was fixed. One foundryman, specializing in automobile cylinders, stated that his machine men now are earning from $9.00 to $13.00 per day, which is due to the fact that when the rate originally was established, the output was much less than at present. The increased production was made possible by the improvements in methods made by the company at a big expense, yet the machine operators are permitted to benefit thereby. It should not be assumed, however, that the firm does not also profit from the enhanced output. The overhead per pound is reduced as the production increases and this manufacturer has concluded that his profit is sufficient, without enlarging it by reducing the rate paid the machine men.

Unless the price established is abnormally high, or other good reasons exist for lowering the rate, it is the concensus of opinion, expressed in the replies, that no change should be made. Every move in this direction is viewed with suspicion, and if the men find that their earning capacity has been impaired, dissatisfaction is sure to follow.

Unskilled Labor Preferred

Whether molders, helpers, laborers, or so-called handymen should be broken in on machines was answered almost unanimously in favor of the unskilled employes. It was pointed out that the molder has an aversion for the machine which is difficult for him to overcome and that he is liable to gage his output by that on the floor or on the bench. On the other hand, if the interest of the skilled molder can be enlisted sufficiently to give the machine a fair trial, with the added inducement of increased pay, it has been the experience that he develops into an excellent operator, his knowledge of foundry work generally, proving advantageous.

Many foundrymen, however, prefer to train laborers, particularly those who display more than the average intelligence of those engaged in this class of work, and wonderful results have followed this practice. The boast is made by one manufacturer, operating a shop that averages about 60 tons of stove plate daily, that not one skilled molder is employed in his plant, and he prefers to train laborers for machine operators, since they have no preconceived notions about what the output on a certain piece of work should be per day. The opportunity to earn more money, of course, proves inviting to this unskilled help, and in this stove shop, the opportunity is eagerly sought for a trial at the machines, which gives them a chance to more than double their earning capacity.

How Machine Men Are Designated

Machine men are variously designated as operators, apprentices and molders. In a majority of cases they are known as ***machine operators*** to distinguish them from molders, although in a few instances, where the day wage rate still persists, they

are styled *molders,* but receive from 10 to 15 per cent less than the skilled men to keep the latter satisfied with their lot. It is obvious, however, that this plan is unwise and one foundryman was sufficiently frank in his reply to admit this to be the case. He said that this plan has been accompanied by a material output on the machines over that obtainable on the floor and he now is considering the piecework plan of payment. The term *apprentice* has been applied to meet the requirements of organized labor for such a designation of the machine operator, since, as a rule, he did not serve his apprenticeship at the trade, and as he could not be classed as a journeyman he was placed in the beginners' class.

Wherever molding machines are installed a phenomenal increase in output results. While this varies considerably, nevertheless it is fair to assume that machine production, at the minimum, will double that obtainable on the floor or bench and it is not unusual to increase the number of molds put up per day five and sixfold. To a large extent, this will depend upon the class of work, the facilities afforded the machine operators for obtaining their sand, special rigging, etc.

Standard Equipment

Today the molding machine is a standard piece of equipment essential to the successful operation of almost every foundry. Its manipulation, regardless of type, is not so involved but that it can be understood readily by men having a laborer's intelligence and, therefore, demonstrations are not nearly so essential as a decade ago, when this device was a novelty in many shops. Unlike almost any other equipment industry, it has been the practice in the molding machine trade to ship machines on trial, to demonstrate their operation in the prospective purchaser's shop at the expense of the builder and to operate them for protracted periods to prove their adaptability to the work for which they are intended. To some extent these practices still persist although they are not paralleled in any other equipment line.

Little value is placed on anything that can be had for the asking, and it is not unusual to find machines, shipped on trial,

stored away in some corner of the shop, awaiting the foundryman's convenience to give them the trial in which the builder is so vitally interested.

When the molding machine is purchased on the same basis as any other commodity, unaccompanied by the trial and demonstration offers, its successful operation invariably is assured. The fact that an investment has been made upon which a return must be shown, immediately enlists the interest of the plant manager, superintendent and foreman, and in place of storing it in some out-of-the-way place, they make it their business to see to it that it is placed in successful operation. Exaggerated claims for output which never were and never could be attained, made by some enthusiastic salesmen, also have proved injurious to the molding machine industry, and in view of the well-known merits of this piece of equipment, it seems no longer necessary to fix a high mark of possible output.

The following extracts from the letters received from foundrymen who have solved the molding machine problem, contain many suggestions and plans which will prove of value to those who are considering the use of this labor-saving equipment:

From a manufacturer of plumbers' brass goods:—

In introducing any new machinery or system into our works we begin by creating in the minds of the operators the thought of self-interest and profit, which always makes a new proposition more inviting. We determine for ourselves certain workmen upon whom we can thoroughly rely to give us a fair and impartial day's work with given equipment to establish the rate.

We believe in and encourage the thought in operators that increased production, even though it results entirely from the improved methods employed, necessarily requires more interest, increases their intelligence and enlarges their earning power.

In our foundry we operate on a bonus system, by which the operator may earn extra pay for extra work and, so far, all losses chargeable to the operation of molding, have been taken from the bonus earned over and above the regular day's pay.

As to terms identifying our foundry employes, beginners are known as helpers for one year, at the end of which time, with the normal progress of affairs, the beginner is put on a machine at which he works for two months as an apprentice molder. During this period he does not receive a bonus, but at the end of two months' experience on the machine his wages are adjusted and he is put on the bonus basis.

From the time of establishing a standard of output in our foundry we have made changes only on rare occasions, and have not met with difficulty when more work was required from the molders, there being an understanding between our firm and operators that a fair amount of work is justice to both sides.

In our foundry office we conduct a complete system of records on which are indicated the quantity of cores for any given article to be made per hour, as well as the number of molds to be made by the molder.

We recently have put into effect a bonus system in our core room which figures about 50 per cent, which has been acceptable to the employes as well as profitable to both themselves and our company. Whatever rates we make in molding or coremaking are guaranteed for one year, at the expiration of which time they may be changed at the option of the company.

The inexperienced core room operator is started at 9 cents per hour and receives this pay for a period of two months; she then has her wages increased to 10½ cents per hour for a period of three months, after which she receives 12 cents per hour for a period of eight months, and is advanced thereafter according to her ability. In addition we offer the following bonus:

Classes of work	A	B	C	D
	Cents per hour.			
Wage rates to which each class of work should be given....................	20-up	17-19	14-16	9-13
Premium rates per hour for cores made in each class of work irrespective of wage rate of employe...............	11	10	9	7

By this method a class "A" girl working on class "C" work would receive as a bonus 9 cents for each hour gained, and a class "C" girl on class "A" work would receive 11 cents per hour bonus money for each hour gained, thus making it an incentive to the low wage earner to work hard for advancement; also, the high wage earner will work very much harder when on low grade work to make a competent bonus. However, we endeavor to give work to employes according to the regular classification as shown.

At an early date we expect to revise our bonus plan, now in operation in our foundry, to correspond closely to that of our core room. We have never had any trouble in adjusting rates nor do we anticipate any in the revision we expect to make in the foundry.

From a manufacturer of textile machinery:—

At present we are running 50 to 60 tons daily, two-thirds of which is poured by the machine molders. Our machine operators are known as machine molders and machine apprentices. They serve a two years' apprenticeship before they are classed as machine molders. All are paid by the piece for the good castings they produce. Any castings which are defective through no fault of theirs are paid for. In the 17 years that I have been in touch with this work, which dates from the start of piece-work, not one price has been lowered, and we have raised a great many.

We find that it pays to make the work as easy as possible, using judgment in not making flasks any heavier to handle than possible, putting in trolley tracks and hoists for the heavier flasks, etc.

Under present conditions, on account of the abnormal demand for help, there are lots of problems dealing with labor that have to be looked at from a different angle than two years ago, and possibly two years hence, but I think there is one point that should not be overlooked at any time, and that is that prices and conditions should be such in any foundry that the machine molder can make a good, fair day's pay.

From a producer of machinery castings:—

Our foundry is almost entirely a molding machine proposition, but of course, we have no trouble from interference of journeymen molders who do not like to see more work produced on a machine than they can produce themselves by hand. Our rule is:

First.—Never start a molding machine with a regular molder.

Second.—Be sure your foreman or instructor fully understands the machine and is favorable to using it and getting all possible out of it. It is useless to attempt to start a machine unless the foreman will do all in his power to make it a success.

Third.—Be sure your patterns and flasks are as near perfect as possible.

Fourth.—Start a good, strong, intelligent, young laborer and instruct him carefully until he fully understands each job. Make a price per casting that will allow the man to make fair wages and watch him carefully until he can do the work alone.

Our machine operators are all called molders by us and are paid on the piecework basis for all good castings produced. We often reduce the piecework price of a job when we change the method of molding or put in a smaller flask; or if we find that the price is too high, we pay the original price set for the first order given to the man, but when the next order comes in the price is cut. We have no trouble with this method.

We have a system in our foundry that helps us a great deal in regard to machine molders. When we hire an inexperienced laborer, he is placed in the yard with the yard gang, and from that gang we pick the best men for our pouring gang, who are paid a little more than those in the yard; from the pouring gang we pick the best men for our molding machines, as they have been in contact with the machines and the operators and have a pretty good idea of how to operate the machines.

These men also know that they are liable to be called at any time to run a molding machine and naturally are working with that end in view, which is a great advantage when we need new men for our machines. While this system could be improved upon, we find that it is a great help to us and the men stay with us better, as there is always a prospect for advancement.

From a manufacturer of malleable castings:—

Our molding machine experience dates back to 1903. However, not until 1912 did our foremen manifest any interest in their successful operation. At that time we received a large order

for draft gear castings, the required quantity per day having been so great that we were obliged to resort to some other method than what we had been following to increase our production. When our first machine was placed in successful operation, interest among our plant executives began to increase immediately and it was only a short time after this until we were mounting all such work that could be made with unskilled labor onto machines, rigged in such a way as to make them practically "fool-proof".

During the same year we bought a hand squeezer and had two aluminum match-plates made by an outside party. These plates were not constructed properly and after considerable trouble, we decided to master the making of match-plates in our own plant.

After we had successfully operated both the stripping plate, roll-over, and squeezer machines, the organization soon saw the wisdom of their use as we realized increased production, better castings, a more liberal use of unskilled labor, pattern repairs were reduced to a minimum and the trouble and anxiety of the foundry foreman in meeting the production demanded was lessened greatly.

Our molding machine men usually are classed as molding machine operators for in the majority of instances they are "green" men when employed and put on work on the machines.

They are all paid on a piecework basis. We have set a piecework price and then lowered it, but this is an exception. Would advise the setting of an equitable price on the job and then maintaining it.

At the present time, we endeavor to make practically every casting, of which there are large quantities, on the machines so that we will not have to be dependent upon so-called skilled labor.

From a builder of power transmission machinery:—

We have been using molding machines in our factory for a great many years and have had no particular objection from our molders. We really run our machines in a separate department from that in which our best molders are working on what might be termed jobbing work, although they are under one general foundry superintendent. Our machine molding is all piecework and we call the operators "machine molders".

We have never made a practice of lowering the wages on our machines, but as wages have advanced we have changed our piecework prices to a higher level. The skill required, of course, is not as great as that of hand work, but the physical ability to perform a good day's work is really more necessary than on skilled work and our machine operators, as a rule, make much more money than do the skilled molders on the good work.

From a producer of light steel castings:—

We started off with one hand squeezer and at that time had some little difficulty in getting the machine started on account of the class of molders we were employing. We finally got one man to work on the machine and we set his rate very

high. He was soon making more money than any man in the plant and it was comparatively easy to get another man started. As far as the men are concerned, we have not had real trouble since the first machine was successfully started.

We found with the introduction of machines, we had to practically do away with what are called molders and now run with approximately 45 handymen or men who were originally laborers or a little above ordinary common labor and 5 men who might be termed molders.

There are 45 men who work on patterns which can be put on boards and the molding made comparatively simple. The other 5 men work on difficult jobs which the ordinary handyman might have trouble with.

All our work is piecework and we run orders as low as 10 pieces and scrap is made up on a piecework basis even though only one casting is required.

We find that this method of running our foundry requires more supervision and that our scrap is a great deal higher with this kind of help. However, our costs are very much lower, not only molding, but all the way through the plant. We find that slow molding means high indirect labor and that if the molders are not putting up a good day's work it is reflected throughout the shop. In our seven years of operation, we have run about one-half the time with what might be called molders and the other half with what might be called handymen and in our opinion there is no question but that the fewer so-called molders you have around the plant, the better costs and the better results you get. Even at the present time, we have comparatively little labor trouble as far as molders are concerned, that is, they are not demanding more money or disturbing things in general.

From a manufacturer of heavy steel castings:—

We have experienced no difficulty in introducing molding machines, and have many of them in constant use. Some of the machines are operated by skilled molders, but the most of them are operated by men who, while they are rated as molders, received all their training in our works. There is no restriction of any kind, any one can operate the machines that we may designate. As a rule we pay piece prices, which are never cut unless we simplify the work so as to increase the output, without entailing any greater amount of labor.

From a builder of farm implements:—

We now have on molding machines all patterns, of which we use over 300 or 400 a year. We have both molders and apprentices and ordinary laborers on these machines at various times, depending upon the character of the work.

Generally speaking, we have a piece price fixed for every pattern placed on a molding machine and after the price is once fixed we have never lowered it. We endeavor to use a good deal of care in fixing the price, and we have never lowered any piece prices either in the foundry or any other department. There has been no opposition in our foundry to the introduction of molding machines, and we have had the co-operation not only of the foremen but of the men themselves.

From one of the U. S. Navy Yard foundries:—

The molding machines installed at this yard are operated by molders who are paid by the day. When these machines were first introduced in the shop, it was necessary to overcome the prejudice of the workmen, some of whom are still prejudiced at the present time. The co-operation of the foundry force in working these machines has come about slowly. Some of the men rather work with the machines than on the floor, while most of the men seem to prefer floor work. As a great deal of the work performed by the foundry at this yard is repair work, the majority of molders are working on the floor.

From a manufacturer of light steel castings:—

It is natural, that when machines were first introduced for the molders to feel somewhat doubtful regarding their future, but our position was to favor the molder wherever possible, giving him the advantage and assistance of the machine, and also the advantage in increased wages according to production

All our machine molding has been on the piecework basis and we have been able to make rates which always have satisfied the molders and helpers.

Your question regarding the lowering of rates is a troublesome one. When a company is forced to use such means to make a profit on its work it always is better to devise some way to increase the day's output rather than lowering the rates.

From a manufacturer of brass castings:—

We have secured the co-operations of our superintendent in our foundry by making a superintendent from a man who had no knowledge of the foundry business at first. A young man from high school was selected and put into a foundry for a year or two's experience and gradually trained into our work, and in this way we got a man who was sympathetic with this mode of operation. Our molding machine operators are known as molders, and they are paid both on the piecework and the day work basis.

Regarding the lowering of a piecework price, we have never lowered this after it was once set, unless the apparatus or equipment was changed in some manner. We are absolutely opposed to the cutting of piecework prices without changing equipment, as we think this is the reason that the piecework system frequently failed in various shops. Piecework undoubtedly will raise output, and will raise the wage for the man if properly handled, but the superintendent must take care to set the right rate first; but if he does make a mistake he must also have the nerve to maintain the rate over an extended period of time if necessary. In this the management should back him, as it is important, from the standpoint of the piecework system, that no rates be cut. We believe that a foundry operating with two or three machines and 15 or 20 molders at the present time is a back number, and that it should be the reverse of this situation, namely, about 20 machines and three or four molders. This means expert patternmakers and the best rigging that a pattern can have, but we believe that it will pay in the long run.

We are certainly in favor of molding machines and are just installing a new pattern shop at quite an expense, in order that our foundry may have the benefit of the best pattern equipment that is possible to obtain.

From a small casting maker:—

We have been running molding machines about 8 years and have never yet changed a price, although we have had men run up to $10.00 per day. In fact, in the 10 years' life of our foundry, we have reduced only four piecework prices of any kind, and each one of these was with the full approval of the men and were due primarily to the fact that we obtained the castings in very much larger quantities than was at first supposed possible.

From a large stove manufacturer:—

Molding machines were first introduced into our foundry eight years ago. At that time no working agreement had been reached with the Stove Founders' National Defense Association of which we are members. The molding machine had the active support of the foundry superintendent and his assistants. The molders assumed an indifferent attitude, offered no opposition, but were openly skeptical as to its success. The operator was included as one of our regular quota of apprentices.

As molding machines became more widely introduced into stove foundries, the molders' union began an active campaign to secure an understanding with the S. F. N. D. A. in the matter of piece prices to be paid for work made upon the molding machines. This culminated in an agreement, in June, 1914, prescribing a piece price basis for work made upon molding machines, both hand and power-operated. This agreement paved the way for the successful and peaceful introduction of molding machines in the stove foundries, under the jurisdiction of the S. F. N. D. A.

In our own experience we can say that our molders threw no obstacles in the way of the introduction of molding machines, but on the other hand displayed a distinct aversion to operating them. The result is we have been compelled to continue our machine operators as of our regular quota of apprentices. We have found that the best operator of molding machines, used in the production of the simpler castings where physical strength and endurance rather than superior skill is the prime requisite, is the ambitious young laborer who has had no previous opportunity to acquire a trade. He considers the machine from a different viewpoint than that of the skilled mechanic. His wage as laborer is generally low and the machine gives him an opportunity to increase his earning capacity and assume a new dignity. The skilled mechanic, on the other hand accustomed to earn good wages, rarely has the incentive for greater earning capacity.

We have found it a good policy, in dealing with the laborer-operator, to place a price upon the work which will enable him to earn a good wage and if his production exceeds our expectations, not to cut the price, but to profit by the experience when new work of a similar character is introduced.

The chief danger in any foundry into which molding machines are first introduced lies, in our judgment, in the exaggerated production sometimes promised by molding machine salesmen. Such promises raise the expectations of the foundryman to an unreasonable degree and arouse the antagonism and opposition of the operator proportionately. We have all learned in these latter days that there is a limit to physical endurance, and in the last analysis, that will always be the determining factor in machine operation and production.

The policy of cutting prices is unwise. It destroys confidence and induces "soldiering" on new jobs. A careful survey of the job should first be made before a price is set. At this stage it is better to err by having the price a little low and then advance it, than to err by setting it too high and then reduce it.

In these days when both foundrymen and molders are better acquainted with the molding machine and its possibilities, the application of a little tact and good judgment will suffice to allay or remove any serious opposition on the part of the working force.

From a manufacturer of valves:—

To secure the co-operation of our foreman we employ a bonus plan, paying the foreman a portion of savings effected in the overhead expense of his department. We also establish a standard of output on which we pay a bonus for increase and saving of cost over and above the set standard.

We do not consider our molding machine men as apprentices. They are usually Italian laborers and we do not consider them molders. We pay on a piecework basis and guarantee, for a certain period, their day rate.

We have lowered the piecework price by re-mounting the patterns on other machines. We consider molding machines to be the only solution of the labor problem in any foundry. Large quantities and duplicate parts warrant the expenditure of proper mounting.

We have recently mounted practically all of our large floor work by a very simple method, which enables us to make a pattern change in a few moments, and has increased our output at least 100 per cent.

From a malleable manufacturer:—

Some years ago the previous management endeavored to put in molding machine equipment, but met with considerable opposition throughout the organization, and the effort was a failure.

About three years ago we started, after convincing our superintendent of the desirability and advantage of power machines. Our initial installation consisted of only one or two machines. We made up match-plate equipment for these, making the molding price lower than the hand pattern price but yet so that the molder could make more by the use of machines than he

could by hand patterns. In other words the price per mold was considerably less, but yet owing to the increased production he is able to obtain, the molding machine operator was enabled to earn more than the hand pattern molder. We kept on sifting in patterns a few at a time until now we have our plant about 75 per cent equipped. The molding machine operators are known as molders and are invariably paid on a piecework basis.

In the early stages of the introduction of the molding machine into our plant we had one molder who had been with us a considerable number of years who had made very strong statements as to what he would do if molding machines were introduced into any shop in which he worked, but strange as it may seem, he was one of the first to ask for a machine and has been one of our best and most persistent molding machine operators, so that there seems to be little or no opposition in our plant against them.

We have, in a number of instances, been able to take men off the gangway and make molders of them; that is, they have learned to make the particular job on which they were broken in for, but of course are not molders in the true sense of the word.

In brief, it is our opinion that if the matter is tactfully and diplomatically handled, there should be no opposition on the part of the men and if the prices are made sufficiently high so that the men can earn better wages by the use of machines than they can the old way, it will not take them long to come to it.

We have accomplished our saving by putting more patterns on a gate in plating them, and putting the match-plate into the sand at a price just a trifle less, or the same price as was paid for the hand equipment with fewer patterns, although we can usually put match-plates in the sand at a lower price than hand patterns.

From a manufacturer of machinery castings:—

We have had no particular difficulty in introducing the machines, there being some slight opposition on the part of the men at first, but this has long since passed, and we have less difficulty in getting men to work on power squeezers than we do on hand patterns, although in these times, it is of course very difficult to get satisfactory employes or enough of them. As the initiative in introducing these machines was wholly on the part of the management, there has been no difficulty in securing the co-operation of the foundry foreman, or, as previously stated, of the men themselves. Our men on machines are classified as molding machine operators, and it has not been customary for us recently to apprentice them; in fact, it is our custom to hire such men as we can and break them in and pay them what we think they are worth, putting them on piecework on the vibrators and match-plates, but not to any great extent on the stripping plate or jolt machines.

It has been our policy for a number of years, never to cut a piecework price. There have been occasional instances when

the price was not properly set, when an adjustment has been necessary. On the other hand, we have a good many prices that have not been reduced for 8 or 10 years, and the men know that these will never be changed as long as the method and patterns remain as they are now.

From a manufacturer of agricultural implements:—

The introduction of the molding machine was begun by this company about 20 years ago. There was at that time some objection by the molders, and some of the men went out as a result. It was found advisable to put other men than molders in charge of the machines, and since that time, it has been the custom not to use molders for any of the machines. A very large number of the stripping plate machines were introduced, as the manufacturing of agricultural implements lends itself readily to duplicate work, and until five years ago this type of machine constituted almost the entire mechanical molding equipment.

At that time, that is to say about 1911, we started work on aluminum match-plates, using a power machine of simple type. We have found the match-plates, properly made and properly used, to be extremely efficient and satisfactory equipment for a very wide range of light castings, and as a result we now have several hundred match-plates in our pattern storage. The machines are operated by laborers in accordance with the almost universal practice in foundry work. Consequently, our machine operators are not known as apprentices and molders, but merely as operators and workmen.

With regard to the question of piecework, we have always made a practice of lowering the prices whenever change of equipment made such alteration possible, or in other words, the wages paid have been made commensurate with the method of doing the work. We have experienced very little trouble over the question of rate as we have always undertaken to make it possible to earn a fairly good rate of pay.

From a manufacturer of radiators:—

We installed several molding machines some time ago, each of which is giving us entire satisfaction. Our daily melt in prosperous times runs up to 60 or 70 tons per day, which amount of work could not be produced without them, but of course, the co-operation of the superintendent and foreman must be obtained.

In reference to molders working on these machines, they have never served an apprenticeship to molding, but are the class of intelligent laborers who have served some time on the machines in which work they have gained quite a proficiency, and now class themselves as molders, although without the assistance of machines, these men could not make a mold of the class worked on. The so-called molders working these machines have in many instances, working piecework, increased their wages 100 per cent, while their helpers, who also are pieceworkers, have increased their wages 100 per cent also. We find that the

best results are obtained from these machines by operating them on a piecework basis. We have made, from time to time, reductions in piecework prices which invariably had the effect of increasing the output.

From a jobbing foundry:—

We have never had any difficulty in getting the co-operation of our superintendent and foundry foreman, and have had very little open opposition from organized labor. While our shop is operated as a union shop, we have always used non-union labor on the molding machines, with the exception of the heavy jolt ramming machines where we have occasionally used a card man to dress up the molds.

Our molding machine operators are merely known as "machine molders" and their assistants are called "machine molders' helpers". We have worked on a basis of both day work and piecework. Owing to the constantly changing nature, however, of our class of work, we find it more advantageous to work on the day work basis, although occasionally when we get a large number of castings to make from one piece, we change over to the piecework basis. We rate the machine molders at about $2.50 per day up, depending upon their ability and experience. We have had cases where the men were exceptionally efficient, and have paid them as high as $3.50 per day, which was equal to the minimum rate paid to the union molders at that time.

The output of machine molders' work is very much in excess of floor molding, ranging from two to five times as great. We cannot recall any instance where once having set the piecework price, it has been lowered. The general tendency of recent years has been more in the line of advancement of wages in the foundry department.

Summing up the situation, would say that we believe the introduction of molding machines is the salvation of the foundries in our district, where the wage rate is constantly advancing and the number of skilled molders constantly decreasing.

From a manufacturer of malleable castings: —

We, like all other malleable iron foundrymen, find it necessary to use squeezers and other molding machines for about 75 per cent of our output. At the present time about 25 per cent of our force are apprentices, working on molding machines. A large number of machine operators are considered molders.

Both apprentices and molders are guaranteed $2.50 per day, but they begin working on a piecework basis. We find that a good handy laborer will be earning about $3.00 per day within 30 days after beginning work. Some of them have earned $4.00 within six weeks from the starting date. We do not lower the piece rate price after it is once set, unless the pattern has been changed so the daily output secured is greater.

From a jobbing shop in the South:—

We are operating under different conditions than the average foundry, our shop being almost strictly a jobbing proposition; therefore, we have been handicapped in the introduction of machines

except on certain classes of work such as grate bars, lintels, etc. All work which we run on the machine we do with unskilled labor; that is, young men or helpers in the foundry who have had experience assisting molders on heavier work.

Our work being such, it is impossible to put it on a piece basis. Therefore, we use what we call a pound or tonnage system. Each molder, or machine operator, is credited each day with the number of pounds of castings, gross weight, put up. Deductions are made for any bad or defective castings and the net amount of clean castings shown on a daily sheet. From these daily sheets a summary sheet is prepared at the end of the month, which shows the number of good castings which each molder or machine operator produces during the month. We have no system of making any charge against the molders for defective castings, inasmuch as all operators are paid an hourly rate, but we have a graduated scale and we insist on a man drawing 45 cents an hour producing a certain amount of tonnage for each day's work during the month, based on the average. We also insist that his losses remain below a certain percentage for the month. These we term molders of the first class.

Molders of the second class have a lower average for the number of pounds per day. They are also allowed a slightly greater percentage of defective castings, and also receive a slightly less hourly pay—probably 40 to 42 cents per hour.

Machine operators are rated by the hour and they are paid according to the tonnage they produce. To illustrate: If we have a pattern which runs by hand, by molders of the second class, 1,000 pounds per day, and we put this pattern on the machine, and if our machine operator, who is usually unskilled, can produce, or does produce, a satisfactory volume over and above the hand operator, he is paid accordingly. Our average from the machines and handymen we estimate to be practically 50 per cent more than a molder of the second class on the same work by hand. Based on this average our machine operators, off the same pattern, would produce say 1,500 pounds of castings per day and would be paid an hourly rate of 30 to 40 cents, according to the tonnage they produce. They are also required, after they have had sufficient experience, to bring their losses within a well defined percentage of the gross amount of castings made. In some instances we have had handymen who delivered sufficient tonnage from the machines to justify paying them the wage of molders of the second class.

From a manufacturer of stoves and heaters:—

We started operating machines with apprentices about seven years ago, starting them day work, and when they became familiar with the job, we put them on a piece basis so that they were able to earn about $3.00 per day. We kept a record of the amount of work each man put up, whether working by the piece or day.

We are members of the Stove Founders' National Defense Association, which has been endeavoring for a number of years to come to an agreement with the I. M. U. regarding the pricing of machine work for journeymen. It was practically conceded by our association that the molders' wages should not be reduced in establishing these prices; that is, such prices should be set as would enable the molder to make as much money on the machine as he would by hand molding.

In March, 1914, this shop set prices on all the machine work with representatives of the I. M. U., which, with some slight modifications, were accepted by the I. M. U. and Stove Founders' National Defense Association. The method employed by us in arriving at these prices was as follows:

We first established from the payroll of the previous year—taking four weeks, one from each season—the average day wage of the hand molders in our shop. We added to this 50 cents to pay the molder for carrying and pouring extra iron, cutting more sand and dumping more molds that would result from the greater output on a machine. We then took each individual machine job, and by referring to the records, determined the average number of molds the operator had put up on the machine, and by dividing the determined average day rate of the regular molders by the output of the machine molder, established the price for that piece.

We priced about 350 boards which are now known as the base prices, and in pricing new work, we determine what it should pay by comparison with these base prices. To illustrate:

If the established price on a board of short centers was 2¾ cents, and we were to price a new board of short centers, provided it was the same size and had no cores or anything to make it more difficult, we would pay the same price. However, if the new board was smaller and the casting lighter, we would agree to some slight reduction, or if it was larger, we would pay a little more than the base board.

After we had set these prices, all of the machine operators who had been working on machines four years, were classed as journeymen molders, and received the new price, which was a considerable advance over what they had been receiving as apprentices. We find, in many instances, that these machine operators do not put up as much work, nor do they work as steadily as heretofore. This may be due to the unprecedented demand for machine molders generally and they apprehend no difficulty in getting a job if they are discharged, but I think the principal reason is the higher wages which they now are being paid.

The Registered Attendance

The following members registered their attendance at the annual meeting of the American Foundrymen's Association, held at Cleveland, O., Sept. 11 to 16, 1916:

ABBE, A. N., purchasing agent, American Hardware Corp., New Britain, Conn.
ABELL, O. J., western editor, *The Iron Age,* Chicago.
ABORN, GEORGE P., manager, Blake & Knowles Steam Pump Works, Cambridge, Mass.
ADAMS, CHAS. E., superintendent, York Foundry & Machine Co., York, Pa.
ADAMS, I. D., salesman, Federal Foundry Supply Co., Cleveland.
ADAMS, W. J., president, Federal Foundry Supply Co., Cleveland.
AHARA, E. H., general superintendent, Dodge Mfg. Co., Mishawaka, Ind.
AIGELTINGER, L. W., factory manager, Wrightsville Hardware Co., Wrightsville, Pa.
AIKEN, C. W., Michigan Steel Castings Co., Detroit.
AIKEN, H. L., Crucible Steel Castings Co., Cleveland.
ALBOHM, W. H., foreman, Hunt-Spiller Mfg. Corp., Boston.
ALEXANDER, DONALD, Mumford Molding Machine Co., Chicago.
ALLEN, L. N., Benton Harbor Malleable Foundry Co., Benton Harbor, Mich.
ALLISON, R. R., Union Switch & Signal Co., Swissvale, Pa.
ALTEN, GEORGE H., Alten's Foundry & Machine Works, Lancaster, O.
ALTEN, AUGUST, foundry foreman, Alten's Foundry & Machine Works, Lancaster, O.
AMAN, JOHN H., treasurer and general manager, Monarch Foundry Co., Detroit.
AMBROSE, STEVE, Ferro Machine & Foundry Co., Cleveland.
ANDERSON, JOHN, foreman, Federal Radiator Co., New Castle, Pa.
ANDERSON, NILS, president, Debevoise-Anderson Co., New York.
ANDROSEN, R. O., Norton Co., Worcester, Mass.
ANGENBRAUM, P. F., Yale & Towne Mfg. Co., Stamford, Conn.
ANSTINE, V. B., superintendent, Lakeside Foundry, Detroit.
APGAR, STANLEY, Taylor-Wharton Iron & Steel Co., High Bridge, N. J.
ARLT, OTTO, salesman, Rogers, Brown & Co., New York.
ARNOLD, H. L., Terre Haute Malleable & Mfg. Co., Terre Haute, Ind.
ASBURY, H. E., president, Enterprise Mfg. Co., Philadelphia.
ATKINSON, W. G., pattern foreman, American Malleables Co., Owosso, Mich.

BACHMAN, WM. A., Hempfield Foundries, Greensburg, Pa.
BACKERT, A. O., editor, *The Foundry,* Cleveland.
BACON, B. T., Pickands, Brown & Co., Chicago.
BACON, CHAS. C., Ross-Tascony Crucible Co., Philadelphia.

BADEN, LOUIS, Niles Tool Works Co., Hamilton, O.
BAILEE, E. J., Seaman-Sleeth Co., Pittsburgh.
BAIRD, W. E., American Gum Products Co., New York.
BAKER, F., Ferro Machine & Foundry Co., Cleveland.
BAKEWELL, D. C., Duquesne Steel Foundry Co., Coraopolis, Pa.
BALDWIN, R. L., electric furnace representative, United States Steel Corporation, New York.
BALES, JAMES, Federal Radiator Co., New Castle, Pa.
BALL, EUGENE F., general manager, Newark Stamping & Foundry Co., Newark, O.
BARNED, F., foreman, McClary Mfg. Co., London, Ontario, Canada.
BARNES, J. A., Kewanee Boiler Co., Kewanee, Ill.
BARR, WM. H., president, National Founders' Association, Lumen Bearing Co., Buffalo.
BARRINGER, J. M., general superintendent, American Malleables Co., Lancaster, N. Y.
BASSETT, H. J., Pratt & Letchworth Co., Ltd., Brantford, Ont., Can.
BATES, RICHARD, superintendent, American Car & Foundry Co., Berwick, Pa.
BATGOLD, A., superintendent, National Car Wheel Co., Pittsburgh.
BATTENFELD, J. N., president, U. S. Molding Machine Co., Cleveland.
BATZER, E. H., patternmaker, Avery Co., Peoria, Ill.
BAXTER, DAVID D., salesman, Frederic B. Stevens, Detroit.
BAUER, F. W., Rogers, Brown & Co., Cincinnati.
BAUMAN, GUSTAV A., foundry superintendent, Jones & Laughlin Steel Co., Pittsburgh.
BEALS, G. W., *The Foundry,* Cleveland.
BEARDSLEY, F. W., Duquesne Steel Foundry Co., Pittsburgh.
BEATTY, WM. G., secretary and general manager, Beatty Bros., Ltd., Fergus, Ont., Can.
BECK, SAMUEL J., foundry superintendent, Pusey & Jones Co., Wilmington, Del.
BUCKS, HENRY W., Bucks Stove & Range Co., St. Louis.
BECKAR, A. J., general superintendent, Atlas Foundry Co., Detroit.
BECKMAN, EDWARD W., foreman, National Tube Co., Kewanee, Ill.
BEEBE, F. A., David Bradley Mfg. Co., Bradley, Ill.
BEEHRMAN, V. H., foreman, Homestead Valve Mfg. Co., Homestead, Pa.
BEITSCH, E. F., Chapman Valve Co., Springfield, Mass.
BELL, C. E., president, C. S. Bell Co., Hillsboro, O.
BELL, DANIEL, Dominion Coal Co., Ltd., Glace Bay, Nova Scotia, Can.
BELL, H. L., Dodge Mfg. Co., Mishawaka, Ind.
BELL, RICHARD S., foundry foreman, New Jersey Zinc Co. of Pennsylvania, Palmerton, Pa.
BENHOFF, H., assistant foreman, National Supply Co., Toledo, O.
BELLSNYDER, THOMAS, foundry foreman, Birmingham Machine & Foundry Co., Birmingham, Ala.
BENNETT, T. B., general superintendent, Maxwells, Ltd., St. Marys, Ont., Can.
BENNETT, WM. B., Union Steel Castings Co., Pittsburgh.
BERGMAN, R., superintendent, Schaum & Uhlinger, Inc., Philadelphia.
BEVER, CLARENCE, assistant manager, Otis Steel Co., Cleveland.
BEVER, J. J., manager, Otis Steel Co., Cleveland.
BIGGERSTAFF, J. W., American Locomotive Co., Schenectady, N. Y.
BILES, JOS. J., George Oldham & Son Co., Philadelphia.
BILTON, C. E., secretary and treasurer, Parsons Foundry Co., Bridgeport, Conn.

Bird, T. S., Michigan Motor Castings Co., Flint, Mich.
Bittner, Frank L., Star Drilling Machine Co., Akron, O.
Black, David, Estate Stove Co., Hamilton, O.
Blackmore, G. C., Federal Radiator Co., New Castle, Pa.
Blackwood, Peter, Blackwood Steel Foundry Co., Springfield, O.
Blair, J. S., Pattin Bros. Co., Marietta, O.
Blake, H. N., Anaconda Copper Mining Co., Anaconda, Mont.
Bloodsworth, H., vice president, Crucible Steel Castings Co., Landsdowne, Pa.
Bloom, Edward B., Goldschmidt Thermit Co., New York.
Blundell, Fred, superintendent, Taylor & Boggis Foundry Co., Cleveland.
Bogard, Richard, superintendent foundry department, Crawford & McCrimmon Co., Brazil, Ind.
Boggis, H. J., Taylor & Boggis Foundry Co., Cleveland.
Booth, Carl H., Snyder Electric Furnace Co., Chicago.
Borg, Victor H., secretary, *Metal Record and Electroplater,* Bridgeport, Conn.
Bourne, R. H., Whiting Foundry Equipment Co., Harvey, Ill.
Bowen, J. R., mechanical engineer, Maytag Co., Newton, Ia.
Bowers, W. J., American Cast Iron Pipe Co., Birmingham, Ala.
Boyd, C. E., McKinnon Dash Co., St. Catherines, Ont., Can.
Boyd, D. C., Galion Iron Works & Mfg. Co., Galion, O.
Bradley, W. P., superintendent of foundries, American Bridge Co., Ambridge, Pa.
Brahney, James A., foreman, Mahoning Foundry Co., Youngstown, O.
Brant, William J., Pittsburgh.
Braucher, Peter S., P. & R. Railway Co., Reading, Pa.
Brayer, Frank N., president, Co-operative Foundry Co., Rochester, N. Y.
Brayton, C. A., Standard Car Wheel Co., Cleveland.
Breitwieser, Edward, Buffalo Co-operative Stove Co., Buffalo.
Breman, Paul, Lawrenceville Bronze Co., Pittsburgh.
Brewster, L. B., Ferro Machine & Foundry Co., Cleveland.
Bridge, Lawrence D., Bridge & Beach Mfg. Co., St. Louis.
Bromley, F. L., Detroit Foundry Co., Detroit.
Brotz, A., chief engineer, Kohler Co., Kohler, Wis.
Brown, L. K., vice president, Interstate Sand Co., Zanesville, O.
Browne, deCourcey, metallurgical engineer, Goldschmidt Thermit Co., New York.
Brunner, Fred J., secretary, Hill-Brunner Foundry Supply Co., Cincinnati.
Brunswick, A., Fort Pitt Malleable Iron Co., Pittsburgh.
Brussel, Fred H., Bay View Foundry, Sandusky, O.
Bryant, R. E., Jefferson Union Co., Lexington, Mass.
Buch, R. S., president, Buch Foundry Equipment Co., Elizabethtown, Pa.
Buehele, Jos., Bay View Foundry, Sandusky, O.
Bull, R. A., president, American Foundrymen's Association, Granite City, Ill.
Bullock, H. E., Illinois Malleable Iron Co., Chicago.
Burgess, W. H., International Malleable Iron Co., Guelph, Ont., Can.
Burman, James W., foundry superintendent, Frank Prox Co., Terre Haute, Ind.
Burns, Charles L., *The Foundry,* Cleveland.
Buses, H., Federal Radiator Co., New Castle, Pa.
Butts, C. G., Jewell Steel & Malleable Co., Buffalo.
Byram, Charles, assistant foreman, National Supply Co., Toledo, O.

CALKINS, L. G., salesman, Rogers, Brown & Co., Chicago.
CALLAN, R. R., superintendent, Michigan Stove Co., Detroit.
CAREY, JAMES A., Hill & Griffith Co., Cincinnati.
CARLSON, E., Ferro Machine & Foundry Co., Cleveland.
CARPENTER, HENRY A., General Fire Extinguisher Co., Providence, R. I.
CARSON, JOHN, Fort Pitt Malleable Iron Co., Pittsburgh.
CASPER, ELMER, Ferro Machine & Foundry Co., Cleveland.
CHADSEY, S. B., assistant general superintendent, Massey-Harris Co., Toronto, Ont., Can.
CHAMBERS, WILLIAM, Garden City Sand Co., Chicago.
CHAMPNEY, W. P. JR., Eberhard Mfg. Co., Cleveland.
CHANDLER, C. B., Havana Metal Wheel Co., Havana, Ill.
CHAPPELKA, A. H., superintendent, Chisholm & Moore Mfg. Co., Cleveland.
CHEESMAN, M. D., manager, Gardner Governor Co., Quincy, Ill.
CHRISTIAN, F. G., Acme Foundry Co., Detroit.
CHRISTY, A. R., Fremont Stove Co., Fremont, O.
CLARK, A. M., Columbia Steel Co., Portland, Ore.
CLARK, A. L., assistant works manager, American Brake Shoe & Foundry Co., Chicago.
CLARK, R. W., Rogers, Brown & Co., New York.
CLELAND, S. H., eastern manager, Black Products Co., Chicago.
CLIFTON, FLOYD, Pittsburgh Iron & Steel Foundry Co., Midland, Pa.
COGHLIN, W. L., Michigan Grey Iron Casting Co., Detroit.
COLBERT, C. F., Sprague Canning Machinery Co., Hoopeston, Ill.
COLE, F. V., *The Foundry,* Cleveland,
COLE, IRA, superintendent, American Road Machinery Co., Delphos, O.
COLEMAN, JAMES H., Tabor Mfg. Co., Philadelphia.
COLLART, H. W., *The Foundry,* Cleveland.
COLLIER, J. H., Crane Co., Chicago.
COLLINS, C. A., Federal Foundry Supply Co., Cleveland.
COLLINS, J. W., production manager, Aluminum Castings Co., Detroit.
COLVIN, CLARENCE H., Colvin Foundry Co., Providence, R. I.
COMSTOCK, GEORGE F., Titanium Alloy Mfg. Co., Niagara Falls, N. Y.
CONE, EDWARD F., *The Iron Age,* New York.
CONNELLEY, C. B., dean Carnegie Institute of Technology, Pittsburgh.
CONWAY, JOHN L., Fremont Stove Co., Fremont, O.
COOK, HARRY H., Titanium Alloy Mfg. Co., Chicago.
COOK, WILLIAM, C., National Steel Casting Co., Montpelier, Ind.
COTTRELL, WILLIAM, Benjamin Electric Mfg. Co., Chicago.
COTTRILL, GEORGE F., vice president, Green's Car Wheel Mfg. Co., St. Louis.
CORBIN, A. F., president, Union Mfg. Co., New Britain, Conn.
COSTLEY, S. R., J. S. McCormick Co., Pittsburgh.
CRAIG, J. E., Star Drilling Machine Co., Akron, O.
CRAWFORD, B. F., secretary, Crawford & McCrimmon Co., Brazil, Ind.
CRAWFORD, ROBT., president, Atlas Foundry Co., Detroit.
CROOK, CHARLES W., foundry foreman, Reed-Prentice Co., Worcester, Mass.
CROPSEY, P. H., General Electric Co., Erie, Pa.
CROSBY, FREDERIC, American Hoist & Derrick Co., St. Paul.
CULLING, H. R., vice president, Carondelet Foundry Co., St. Louis.
CUNNINGHAM, C. R. H., president, Crucible Steel Casting Co., Lansdowne, Pa.
CUNNINGHAM, J. D., superintendent, National Car Wheel Co., Pittsburgh.
CUNNINGHAM, J. J., Western Foundry Co., Ltd., Wingham, Ont., Can.

DALLWIG, BRUNO, superintendent and treasurer, Wisconsin Aluminum Foundry Co., Manitowoc, Wis.
DAVIDSON, L., Canadian Northern Railway, Winnipeg, Manitoba, Can.
DAVIES, GEORGE S., Dover Fire Brick Co., Cleveland.
DAVIS, EDWARD, Federal Radiator Co., New Castle, Pa.
DAVIS, L. A., foreman, Munnsville Plow Co., Munnsville, N. Y.
DAVIS, LUTHER A., Federal Radiator Co., New Castle, Pa.
DEAN, W. H., Frederic B. Stevens, Indianapolis, Ind.
DEAN, WM. J., foundry superintendent, Saco-Lowell Shops, Biddeford, Me.
DEBEVOISE, PAUL, treasurer, Debevoise-Anderson Co., New York.
DEBOUX, SCOTT, American Malleables Co., Lancaster, N. Y.
DEGLES, J., salesman, Tabor Mfg. Co., Philadelphia.
DELANEY, J. W., Holt Mfg. Co., Peoria, Ill.
DELANO, F. E., General Electric Co., Erie, Pa.
DELVAN, T. J., foundry foreman, Duquesne Steel Foundry Co., Pittsburgh.
DEMPSTER, D. C., Dempster Mill Mfg. Co., Beatrice, Nebr.
DENNEGAN, A. I., foundry superintendent, Power Specialty Co., New York.
DERBY, FRED G., foreman, Taylor & Boggis Foundry Co., Cleveland.
DETWEILER, H. H., treasurer, Enterprise Co., Columbiana, O.
DE VANEY, W. H., president, Hoosier Castings Co., Connersville, Ind.
DICKEY, J. M., Meadville Malleable Iron Co., Meadville, Pa.
DILLER, H. E., General Electric Co., Erie, Pa.
DITTY, RALPH, Federal Foundry Supply Co., Cleveland.
DOBSON, O. C., salesman, Carborundum Co., Pittsburgh.
DODD, N. D., Interstate Sand Co., Zanesville, O.
DODGE, F. H., S. Obermayer Co., Chicago.
DONALD, H. R., manager, Osborn Mfg. Co., Milwaukee.
DONALDSON, J., foundry superintendent, Miller Bros. & Son, Montreal, Quebec, Can.
DOLAN, M. E., General foreman, Louisville & Nashville Railroad, Louisville.
DONAGHY, EDWIN C., Temple Malleable Iron & Steel Co., Philadelphia.
DOPP, J. W., International Molding Machine Co., Chicago.
DORSEY, W. A., Bonney-Floyd Co., Columbus, O.
DOSEY, W. H., head instructor, Carnegie Institute of Technology, Pittsburgh.
DOYING, W. A. E., inspecting engineer, Panama Canal, Washington, D. C.
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FREDERICKS, WM., Atlas Foundry, Detroit.
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GIBERSON, M. B., Blackwood Steel Foundry Co., Springfield, O.
GIBNEY, JAMES W., works manager, W. P. Taylor Co., Buffalo.
GIELE, H. F., Grabler Mfg. Co., Cleveland.
GILMORE, W. R., Superior Steel Castings Co., Benton Harbor, Mich.
GLASS, JAMES, Wheeling Mold & Foundry Co., Wheeling, W. Va.
GLASS, J. M., salesman, Hill & Griffith Co., Cincinnati.
GLASSCOT, THOS., Pickands, Brown & Co., Milwaukee.
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GOLDEN, ALBERT P., Bethlehem Steel Co., Baltimore.
GOLDEN, J. P., Goldens Foundry & Machine Co., Columbus, Ga.
GOOD, THOMAS R., Turner & Seymour Mfg. Co., Torrington, Conn.
GORDON, F. E., president, Gordon Sand Co., Conneaut, O.
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GREEN, K. S., Greene's Car Wheel Mfg. Co., St. Louis.
GREENBAUM, WILLIAM, Acme Foundry Co., Cleveland.
GREENE, W. B., Palmer & De Mooy Foundry Co., Cleveland.
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GREGORY, WM. T., Michigan Motor Castings Co., Flint, Mich.
GRIFFITHS, S., manager foundries, Fairbanks-Morse Co., Beloit, Wis.
GRISWOLD, R. W., Griswold Mfg. Co., Erie, Pa.

GRISWOLD, W. A., Gray & Dudley Hardware Co., Nashville, Tenn.
GRUNAU, WM. F., American Locomotive Co., Schenectady, N. Y.
GRUSS, WM. J., Pickands, Mather & Co., Cleveland.
GROBB, CHAS. H., Massey-Harris Co., Ltd., Toronto, Ont., Can.
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HAHN, GEORGE J., manager, Hahn Brass Co., New Hamburg, Ont., Can.
HARE, A. P., Kewanee Boiler Co., Kewanee, Ill.
HALL, JOHN H., Taylor-Wharton Iron & Steel Co., High Bridge, N. J.
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MCMAHON, R. E., M. A. Hanna & Co., Cleveland.
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MCNEAL, J. M., foundry superintendent, Landis Machine Co., Waynesboro, Pa.

MACKIE, HUGH A., foreman, Homestake Mining Co., Lead, S. D.
MALTBY, G. A., M. A. Hanna & Co., Cleveland.
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MARTIN, GEORGE H., Davis Foundry, Hornell, N. Y.
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MEISTER, W. F., Pattin Bros Co., Marietta, O.
MEIXER, H. M., Hempfield Foundry, Greensburg, Pa.
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MILLER, C. M., Superior Foundry Co., Cleveland.
MILLER, E. P., general manager, Lennox Furnace Co., Marshalltown, Ia.
MILLER, H. H., Headford Bros. & Hitchins, Waterloo, Ia.
MILLER, L. I., Superior Foundry Co., Cleveland.
MILLER' W. H., foundry foreman, Beere & Mansur Co., Moline, Ill.
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MILLS, R. H., American Gum Products Co., Detroit.
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MOLDENKE, RICHARD, Watchung, N. J.
MOLL, CARL. F. Grote Mfg. Co., Evansville, Ind.
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